**INSTRUCTION MANUAL FOR THE**
**COLLINS PLUS/2000 SYSTEM**
**SoftwareVersion 4.07**

Manual Version: October 2003

#762007

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**Important:**
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**TABLE OF CONTENTS**


**SECTION ONE --GETTING STARTED ..... 15**

*System Description ..... 15*
*System Requirements ..... 15*
*Documentation ..... 15*
*Technical Support ..... 16*
*Powering up the System ..... 16*
*Accessing the PLUS Program ..... 16*
*Getting Around the PLUS Program ..... 17*
*Screen Messages ..... 18*
*Installation Procedure for Collins Plus/SQL 2000 Software Versions 4.04 – 4.07 ..... 18*
Uninstalling Existing PLUS Software ..... 18
Plus2k Program Setup (Installation) ..... 19
Notes on Plus/SQL 2000 Languages ..... 20
Notes on Component Installation ..... 21
Installing a New Database ..... 25
Backing Up Existing Databases Prior to Upgrading ..... 27
Notes on the Database Backup Wizard ..... 28
Upgrading an Existing Database ..... 29

**SECTION TWO -- ENTERING PATIENT INFORMATION AND CREATING STUDIES ..... 31**

*About Patient Studies ..... 31*
*Creating a Patient Study ..... 31*
Entering Customized Tabs and Fields ..... 35
*Searching for a Patient ..... 36*
*The Patient Cache ..... 37*
*Creating a New Study on a Previously Tested Patient ..... 39*
*Modifying an Existing Study ..... 39*
*Changing the Patient ID ..... 39*
*Notes Editor ..... 39*
Inserting Auto Text in the Notes Editor ..... 41
Creating an Auto Text File ..... 41
*Closing and Opening a Study ..... 44*
*Study Status ..... 47*
*Prediction Equations ..... 48*
*Confidence Intervals ..... 48*
*Database Utilities ..... 49*

**SECTION THREE - CONFIGURING THE PLUS PROGRAM ..... 54**

*About Configuration ..... 54*
*Hardware Configuration ..... 55*
GS Hardware Configuration ..... 55
CPL Hardware Configuration ..... 55
Eaglet Configuration ..... 57
$BP^D$ Configuration ..... 58
GEM/Owl/Hawk Configuration ..... 58
Eagle Configuration ..... 59
*The Configuration Editor ..... 60*
General Configuration ..... 60
Patient Information Configuration ..... 63
Forced Vital Capacity Configuration ..... 64
Maximum Voluntary Ventilation Configuration ..... 66
Lung Volumes Configuration ..... 67
$N_2$ Washout Configuration ..... 69
Diffusion Capacity Configuration ..... 70
PImax/PEmax (MIPS/MEPS) Configuration ..... 73
Body Plethysmography Configuration ..... 74
FVC Challenge Editor ..... 76
Determining Nebulizer Output ..... 78

*System Security* ..... *79*
*Database Selection* ..... *82*
*Code Editor* ..... *83*
*Interpretation Editor* ..... *86*
*Trend Configuration* ..... *90*
*The PLUS/2000 Language Editor* ..... *91*

**SECTION FOUR -- CALIBRATION ..... 95**

*About Calibration* ..... *95*
*Barometric Pressure and Room Temperature Calibration* ..... *97*
*Spirometer Calibration* ..... *99*
If you are connected to the Balloon Valve: ..... 99
If you are connected directly to the Spirometer, not using the Balloon Valve: ..... 100
Verifying Calibration ..... 101
*Pneumotach Calibration* ..... *101*
Verifying Flow Calibration ..... 103
Recommended Verify Procedure ..... 103
*$N_2$ Washout Lung Volumes Calibration* ..... *105*
*Diffusion Calibration* ..... *108*
*Mouth Pressure Calibration* ..... *109*
*Calibration History* ..... *110*
*Calibration Report* ..... *113*

**SECTION FIVE -- PATIENT TESTING ..... 116**

*Preliminary Tasks* ..... *116*
*About Spirometry* ..... *117*
*The Forced Vital Capacity Test* ..... *117*
Preparing Equipment for the FVC Test ..... 117
If Using the Balloon Valve as the Testing Device... ..... 117
If Connected Directly to the Spirometer for Testing, and therefore not using the valve... ..... 117
If Using the MicroTach... ..... 117
FVC Calibration ..... 117
Conducting the FVC (Forced Vital Capacity) Test ..... 118
FVC Test with the Valve ..... 118
FVC Test with the Pneumotach ..... 120
FVC Test with Spirometer ..... 120
FVC Review ..... 120
FVC Back Extrapolation ..... 120
The FVC Datasheet ..... 121
Discarding an FVC Effort ..... 122
Undo Command ..... 123
FVC Volume-Time Graph ..... 123
FVC Flow-Volume Loop ..... 123
FVC Disability Graph ..... 124
Summary of FVC Options ..... 124
More FVC Options ..... 125
Exiting the FVC Program ..... 126
*The MVV Test* ..... *127*
Preparing Equipment for the MVV Test ..... 127
MVV Calibration ..... 127
Performing the MVV (Maximal Voluntary Ventilation) Test ..... 127
Ending the MVV Test ..... 128
MVV Duration ..... 129
MVV Test with Pneumotach ..... 130
MVV Test with Spirometer ..... 130
MVV Review ..... 130
MVV Tabular Data ..... 130
MVV Reported Effort ..... 131
MVV Graph ..... 131
Summary of MVV Options ..... 132
More MVV Options ..... 132
Exiting the MVV Program ..... 133
*The Lung Volumes Test – Helium Dilution Method* ..... *133*

Preparing Equipment for the Lung Volumes Test ..... 134
Lung Volumes Calibration ..... 134
Conducting the Lung Volumes Test ..... 134
Conducting the FRC Test ..... 134
Conducting the SVC Test ..... 138
Alternate SVC Method ..... 139
Lungs Volumes, FRC or SVC Alone ..... 140
Lung Volumes Review ..... 141
FRC Helium Readings ..... 141
Lung Volumes Datasheet ..... 142
Lung Volumes, Discarding an Effort ..... 144
Lung Volumes Graphs ..... 144
Lung Volumes Reported Effort and Averaging Results ..... 145
Summary of Lung Volumes Options ..... 146
More Lung Volumes Options ..... 146
Exiting the Lung Volumes Program ..... 148
*The Lung Volumes Test – Nitrogen Washout Method* ..... *149*
Preparing Equipment for the $N_2$ Washout Test ..... 149
Lung Volumes Calibration ..... 149
Conducting the $N_2$ Washout Test ..... 149
Conducting the SVC Test ..... 154
Lung Volumes Review ..... 156
Lung Volumes Datasheet ..... 157
Deleting an Effort ..... 159
The Gas Datasheet ..... 159
Lung Volumes Graphs ..... 159
Lung Volumes Reported Effort and Averaging Results ..... 160
Summary of Lung Volumes Options ..... 161
More Lung Volumes Options ..... 161
Right-Click on the FRC Graph: ..... 161
Right-Click on SVC Graph: ..... 161
Right-click on Gas Datasheet: ..... 162
Right-click on Main Datasheet: ..... 162
Exiting the Lung Volumes Program ..... 163
*The Diffusion Capacity Test* ..... *163*
DSB Preparing Equipment for Testing ..... 164
DSB Calibration ..... 164
Conducting the DSB Test ..... 164
DSB Review ..... 167
DSB Datasheet ..... 168
Discarding a Dsb Effort ..... 168
DSB Test Graphs ..... 168
The DL Graph ..... 168
The Disability Graph ..... 168
The Washout Graph ..... 168
DSB Reported Effort and Averaging Results ..... 170
Summary of Dsb Options ..... 170
More Dsb Options ..... 170
Exiting the Diffusion Program ..... 171
*The $PI_{max}$-$PE_{max}$ Test* ..... *172*
Preparing the System for PImax-PEmax Testing ..... 172
PImax-PEmax Calibration ..... 172
Conducting the PImax/PEmax Test ..... 172
PImax-PEmax Review ..... 176
The PImax-PEmax (MIPS-MEPS) Datasheet ..... 176
PImax-PEmax (MIPS-MEPS) Reported Effort ..... 176
Summary of PImax-PEmax Options ..... 177
Exiting the PImax-PEmax Program ..... 177
*FVC Challenge Testing* ..... *178*
About Challenge Testing ..... 178
Setting up the Dosimeter ..... 178
Conducting Challenge Tests ..... 178
*Manual Entry of Test Data* ..... *180*

**SECTION SIX -- BODY PLETHYSMOGRAPHY ..... 182**

*$BP^D$ Calibration ..... 182*
Calibrating the Barometric Pressure and Temperature Probe ..... 182
Calibrating the Pneumotach ..... 183
Calibrating Mouth Pressure ..... 183
Calibrating the Box Pressure-Volume Relation ..... 183
*Plethysmography Testing ..... 184*
Test Descriptions ..... 184
Lung Volumes (VTG) ..... 184
Airway Resistance (Raw) ..... 184
Slow Vital Capacity (SVC) ..... 184
Combined Tests ..... 184
Preliminary Tasks ..... 185
Conducting Tests ..... 185
The Combined Maneuver ..... 186
Notes on the Combined Maneuver ..... 188
Breaking out of the Combined Maneuver to Conduct Manual Tests ..... 188
Acceptable Tracings ..... 189
Conducting Stand-alone Lung Volumes and SVC Tests ..... 189
*Plethysmography Review and Editing Options ..... 190*
Graph Review ..... 190
Windows® View Menu Option ..... 190
Magnification ..... 190
Adjusting Best-Fit Lines for Vtg and Raw Calculations ..... 191
Positioning Tidal Breath Lines ..... 192
Copying or Printing of Graphical Data ..... 193
Graph Scaling ..... 193
Tabular Data Review Functions ..... 193
Tabular Data Pane Control Functions ..... 194
*Conducting Spirometry Tests with the $BP^D$ Pneumotach ..... 194*
FVC and MVV Tests ..... 194
PImax/PEmax Tests ..... 194

**SECTION SEVEN –THE REPORT DESIGNER (STANDARD PATIENT REPORTS) ..... 196**

*About Patient Reports ..... 196*
*Report Definitions ..... 197*
*Creating Report Definitions ..... 197*
Text Section ..... 200
Demographic Information Section ..... 201
Tabular Data Section ..... 202
Graph Section ..... 206
Challenge Section ..... 212
Interpretation Section ..... 212
Study Notes Section ..... 213
Page Break Option ..... 213
Extended Fields Section ..... 213
Trend Section ..... 213
Trend Graph Section ..... 214
*Making Changes to a Report Definition ..... 215*
*Saving and Exiting the Report Program ..... 216*
PRINTING REPORTS ..... 216

**SECTION EIGHT – EXTENDED PATIENT REPORTS ..... 219**

*About the Extended Reports Option ..... 219*
*Creating a New Extended Report ..... 222*
Setting up the Picture Box Section ..... 227
Setting up a Text Section ..... 232
Setting up the Patient Information and Study Data Box ..... 233
The Patient Photo Section ..... 235
User Defined Fields Section ..... 236
Tabular Data Section ..... 236
Challenge Data Section ..... 246
FVC Flow-Volume Graph ..... 248

FVC Volume-Time Section ... 252
The Challenge Graph Section ... 253
The MVV Graph Section ... 256
The MIP/MEP Graph Section ... 257
The FRC Graph Section (He dilution) ... 258
The Nitrogen Washout Graph Section ... 259
The DL Graph Section ... 260
The Disability Graph Section ... 261
The Lung Volumes Bar Graph Section ... 263
The Volume Graph Section ... 265
The Body Box Raw Graph Section ... 268
The Body Box Composite Graph Section ... 269
The Interpretation Section ... 270
The Notes Section ... 271
Physician Review ... 272
PRINTING REPORTS ... 274
*Exiting the PLUS/2000 Program and Powering Down the System* ... *276*

**SECTION NINE – CPL DIAGNOSTIC SOFTWARE ... 277**

*Accessing CPL Diagnostics* ... *277*
*Checking the Valve Balloons* ... *277*
*Conditioning the Balloons* ... *278*
*Conducting a Leak Test* ... *278*
*Obtaining a Diagnostic History* ... *280*

**SECTION TEN -- THE PLUS/SQL 2000 PREDICTED EDITOR ... 282**

*Starting the Predicted Editor:* ... *282*
*Menu Options:* ... *282*
*Opening a predicted data .xml file:* ... *283*
*The Equation Editor:* ... *284*
*Entering equations, constants, ranges, and RSD data in the Equation Script Editor:* ... *286*
*The Predicted Equation Protocol Editor:* ... *287*
Age Ranges in Protocols: ... 289
Derived Equations: ... 290
*The Use of Functions in Predicted Equations:* ... *292*
*Testing Equations:* ... *293*
*The Handling of Parameter Units:* ... *296*
*Database Utilities – Predicted Tab* ... *296*
*Importing Predicted Equations and/or Protocols to a PLUS/2000 Database* ... *297*
*Exporting Predicted Equations and/or Protocols* ... *298*
*Summary of VBScript Operators and Rules* ... *300*

**APPENDIX A -- LICENSING AGREEMENT ... 302**

**APPENDIX B -- REVIEW OF PULMONARY FUNCTION TERMINOLOGY ... 304**

*Testing Operations* ... *304*
*Mechanics of Breathing* ... *304*
Forced Expired Volume (FEV) or Forced Vital Capacity (FVC) Maneuver ... 304
Maximum Voluntary Ventilation (MVV) Maneuver ... 304
Slow Vital Capacity (SVC) and Tidal Volume (TV) Maneuver ... 305
*Lung Volumes* ... *305*
*Diffusing Capacity* ... *306*
*Symbols Used for Respiratory Physiology* ... *306*
*Equations for BTPS, STPD and STPD37 Correction* ... *307*
*CPL Pulmonary Modules -- Basic Theory* ... *308*
Spirometry ... 308
*Lung Volumes* ... *308*
*Diffusing Capacity* ... *309*

**APPENDIX C -- PREDICTED PROTOCOL LISTINGS AND AUTHOR REFERENCES.....310**

*References for Prediction Equations .....310*
*Predicted Equation Authors for the PLUS/2000 Protocols .....315*

**APPENDIX D – LOGIC OF THE EXTENDED ELLIS INTERPRETATION PROGRAM.....328**

**APPENDIX E – USING MICROSOFT® EXCEL WITH PLUS/SQL 2000.....354**

## LIST OF FIGURES


Figure 1-1. The PLUS/2000 Opening Screen ..... 16
Figure 1-2. The GoTo Menu ..... 17
Figure 1-3. The Add/Remove Programs Dialog ..... 18
Figure 1-4. Selecting Yes to Begin the Uninstall Procedure ..... 19
Figure 1-5. Window Indicating Progress of Uninstall Procedure ..... 19
Figure 1-6. The Installation Language Dialog ..... 20
Figure 1-7. The Component Installation Dialog ..... 21
Figure 1-8. Upgrade Dialog for Data Engine ..... 22
Figure 1-9. Component Installation Dialog Showing Data Engine Installed ..... 22
Figure 1-10. Selecting the PLUS Software Option to Install ..... 23
Figure 1-11. The Plus/SQL 2000 Installation Wizard ..... 23
Figure 1-12. The User Information Dialog ..... 24
Figure 1-13. The Select Features Dialog ..... 24
Figure 1-14. The *Ready to Install Application* Dialog ..... 25
Figure 1-15. Component Installation Dialog Showing PLUS Software Installed ..... 25
Figure 1-16. The Database Language Selection Dialog ..... 26
Figure 1-17. Default Locations for Database Files ..... 26
Figure 1-18. Database Information Dialog ..... 26
Figure 1-19. The Database Start-Setup Dialog ..... 27
Figure 1-20. The Database Backup/Restore Dialog ..... 27
Figure 1-21. Selecting the Database to Back Up ..... 28
Figure 1-22. The Save Backup File Dialog ..... 28
Figure 1-23. The Language Selection Dialog for Database Upgrade ..... 29
Figure 1-24. The Files Location Dialog for the Database Upgrade ..... 29
Figure 1-25. The Database Information Dialog for Database Upgrade ..... 30
Figure 1-26. Backup Warning Screen for Database Upgrade ..... 30
Figure 1-27. The Start Upgrade Dialog for Database ..... 30
Figure 2-2. Sample Patient Information Screen ..... 35
Figure 2-3. The User-Defined Tabs and Fields Dialog ..... 35
Figure 2-4. The Patient Cache Editor ..... 38
Figure 2-5. Patient Search Screen ..... 38
Figure 2-6. The Notes Editor ..... 40
Figure 2-7. Inserting Auto Text in the Notes Editor ..... 41
Figure 2-8. Selecting the Auto Text Editor ..... 42
Figure 2-9. Auto Text Editor Opening Screen ..... 42
Figure 2-10. Creating Categories in the Category List Dialog ..... 43
Figure 2-11. Selecting from the Category List ..... 43
Figure 2-12. Adding Lines to the Auto Text File ..... 44
Figure 2-6. The Close Study Option on the File Menu ..... 44
Figure 2-7. The Close Study Dialog ..... 45
Figure 2-8. Close Study Reasons Dialog ..... 45
Figure 2-9. The Open Study Dialog ..... 46
Figure 2-10. The Open Study Reasons Dialog ..... 47
Figure 2-11. Sample Study Status Screen ..... 48
Figure 2-12. The Export Study Dialog ..... 50
Figure 2-13. Sample Export Study File ..... 50
Figure 2-14. The Import Study Dialog ..... 51
Figure 2-15. The Move Study Dialog ..... 52
Figure 3-1. The Configuration Options on the Tools Menu ..... 55
Figure 3-2. The CPL Configuration Tab ..... 56
Figure 3-3. Configuration Tab for the Collins Eaglet ..... 57
Figure 3-4. Configuration Tab for the Collins BP$^{D}$ ..... 58
Figure 3-5. Configuration Tab for the Collins GEM ..... 59
Figure 3-6. Configuration Tab for the Collins Eagle ..... 59
Figure 3-7. The Configuration Editor ..... 60
Figure 3-8. The General Configuration Dialog ..... 61

Figure 3-9. The Patient Information Configuration Screen ..... 63
Figure 3-10. The FVC Configuration Screen ..... 64
Figure 3-11. The MVV Configuration Screen ..... 66
Figure 3-12. Lung Volumes Configuration Screen ..... 67
Figure 3-13. The $N_2$ Washout Configuration Screen ..... 69
Figure 3-14. Diffusion Capacity Configuration Screen ..... 71
Figure 3-15. The PImax/PEmax Configuration Screen ..... 73
Figure 3-16. The Plethysmography Configuration Screen ..... 74
Figure 3-17. FVC Challenge Editor ..... 76
Figure 3-18. The System Security Dialog ..... 80
Figure 3-19. Icons used in Security Dialog ..... 80
Figure 3-20. Adding a Group to the Security List ..... 81
Figure 3-21. The Open Database Option on the File Menu ..... 82
Figure 3-22. The Database Connection Dialog ..... 82
Figure 3-23. The Advanced Database Connection Dialog ..... 83
Figure 3-24. Selecting the *Code Editor* Option from the Tools Menu ..... 84
Figure 3-25. The Code Editor Dialog ..... 84
Figure 3-26. Sample List for the Code Editor ..... 85
Figure 3-27. Sample Interpretation Tree ..... 87
Figure 3-28. Sample Interpretation Editor Line ..... 87
Figure 3-29. The Interpretation Branch Editor ..... 88
Figure 3-30. Interpretation Equation Builder ..... 89
Figure 3-31. Sample Trend Configuration Screen ..... 91
Figure 3-32. Location of PLUS Language Files ..... 91
Figure 3-33. Selecting the PlusStings.exe File ..... 92
Figure 3-34. Selecting Open from the File Menu ..... 92
Figure 3-35. Locating the Language.dat File ..... 93
Figure 3-36. The PLUS String Editor ..... 93
Figure 4-1. The Calibration Option on the Tools Menu ..... 95
Figure 4-2. System Calibration Tree ..... 96
Figure 4-3. Calibration Tree with Transducer Data ..... 97
Figure 4-4. Sample Calibration Table ..... 98
Figure 4-5. Example of Zero-Flow Tracing ..... 102
Figure 4-6. Example of an Inspired Flow Calibration Tracing ..... 102
Figure 4-7. Example of an Expired Flow Calibration Tracing ..... 103
Figure 4-8. Sample Recommended Flow Verify Tracings ..... 104
Figure 4-9. The $N_2$ Gas Analyzer Calibration Tree ..... 105
Figure 4-10. $N_2$ Analyzer Calibration Review Data ..... 106
Figure 4-11. Continuing with $N_2$ Analyzer Calibration ..... 106
Figure 4-9. Selecting the History Option for the Pneumotach ..... 111
Figure 4-10. Sample Calibration History Data for the Pneumotach ..... 111
Figure 4-11. Viewing Calibration Data for All Instruments during Test Review ..... 112
Figure 4-12. Calibration Report Generator ..... 113
Figure 4-13. Calibration Report Page Setup Screen ..... 113
Figure 4-14. Advanced Calibration Report Formatting Options ..... 114
Figure 4-15. Sample Font and Color Option Screens for the Calibration Report Generator ..... 114
Figure 5-1. A Completed FVC Maneuver ..... 119
Figure 5-2. Menu of Reported Effort Options ..... 122
Figure 5-3. Flow-Volume Loops Overlaid ..... 124
Figure 5-4. Sample FVC Disability Graph ..... 124
Figure 5-5. The Right-Click Menu for the Flow-Volume Loop ..... 125
Figure 5-6. The Right-Click Menu for the FVC Datasheet ..... 126
Figure 5-7. A Completed MVV Test ..... 128
Figure 5-8. Appearance of MVV Graph When Test is Ended Automatically ..... 129
Figure 5-9. Appearance of MVV Graph When Test is Ended Early ..... 129
Figure 5-10. Sample MVV Reported Effort ..... 131
Figure 5-11. The MVV Graph Right-Click Menu ..... 132
Figure 5-12. The MVV Datasheet Right-Click Menu ..... 132
Figure 5-13. He Dilution Test Selected from the GoTo Menu ..... 133

Figure 5-14. Opening Screen for the Lung Volumes Test ..... 135
Figure 5-15. Opening Lung Volumes Screen with Detailed Datasheet ..... 136
Figure 5-16. A Completed FRC Test ..... 138
Figure 5-17. A Completed SVC Test ..... 139
Figure 5-18. The Alternate SVC Method ..... 140
Figure 5-19. Detailed FRC Datasheet Showing Helium Readings ..... 142
Figure 5-20. The Lung Volumes Datasheet ..... 143
Figure 5-21. Averaging Lung Volume Data ..... 146
Figure 5-22. Right-Click Menu for the FRC Graph ..... 147
Figure 5-23. Right-Click Menu for the SVC Graph ..... 147
Figure 5-24. Right-Click Menu for the Detailed FRC Datasheet ..... 147
Figure 5-25. Right-Click Menu for the Lung Volumes Datasheet ..... 148
Figure 5-26. $N_2$ Washout Test on the GoTo Menu ..... 150
Figure 5-27. $N_2$ Washout Test Opening Screen ..... 150
Figure 5-28. $N_2$ Washout Test Graphs ..... 151
Figure 5-29. The $N_2$ Washout Test Screen ..... 153
Figure 5-30. The Resulting $N_2$ Washout Tracing ..... 154
Figure 5-31. Conducting the SVC Test ..... 155
Figure 5-32. A Completed SVC Test Graph ..... 156
Figure 5-33. The Tidal Volume Graph and Right-Click Option Menu ..... 157
Figure 5-34. The Lung Volumes Datasheet ..... 158
Figure 5-35. The $N_2$ Washout Gas Datasheet ..... 159
Figure 5-36. The $N_2$ Datasheet Right-Click Menu ..... 160
Figure 5-37. Averaging Lung Volume Data ..... 161
Figure 5-38. Right-Click Menu for the FRC Graph ..... 161
Figure 5-39. Right-Click Menu for the SVC Graph ..... 162
Figure 5-40. Right-Click Menu for the Detailed FRC Datasheet ..... 162
Figure 5-41. Right-Click Menu for the Lung Volumes Datasheet ..... 163
Figure 5-42. The Jones-Meade Method of Measuring Breath-hold Time ..... 164
Figure 5-43. The Opening Dsb Screen ..... 165
Figure 5-44. A Completed Dsb Test Screen ..... 167
Figure 5-45. The Dsb Disability and Washout Graphs ..... 169
Figure 5-46. The Opening PImax/PEmax Screen ..... 173
Figure 5-47. Sample Completed MEP Test ..... 174
Figure 5-48. Sample Completed MIP Test ..... 175
Figure 5-49. Sample Combined MIP/MEP Test ..... 175
Figure 5-50. Sample MIP/MEP Datasheet ..... 176
Figure 5-51. The Manual Entry Dialog ..... 181
Figure 6-1. The Calibration Tree for the $BP^D$ ..... 182
Figure 6-2. The Plethysmography Opening Screen ..... 186
Figure 6-3. A Completed Combined Test Screen ..... 188
Figure 6-4. A Standard PLUS/2000 Review Screen for Plethysmography ..... 190
Figure 6-5. A Normal Size VTG Screen ..... 191
Figure 6-6. A VTG Screen Magnified ..... 191
Figure 6-7. Sample Context Menu ..... 192
Figure 6-8. The Lung Volumes Review Screen ..... 193
Figure 7-1. Sections Arranged in a Sample Report Definition ..... 197
Figure 7-2. Selecting the *New* Report Option ..... 197
Figure 7-3. Opening a Blank Report File ..... 198
Figure 7-4. Report Insert Menu ..... 198
Figure 7-5. Deleting a Report Section ..... 199
Figure 7-6. Moving a Report Section ..... 199
Figure 7-7. Several Report Definitions Open Simultaneously ..... 199
Figure 7-8. The Text Area Report Dialog ..... 200
Figure 7-9. Sample Text Section in a Report Definition ..... 200
Figure 7-10. The Demographic Report Dialog ..... 201
Figure 7-11. Arranging Fields in the Reports Demographic Section ..... 201
Figure 7-12. Sample Demographic Section in a Report Definition ..... 202
Figure 7-13. The Tabular Report Dialog ..... 202

Figure 7-14. Selecting a Field for the Tabular Report ..... 203
Figure 7-15. Assigning Column Headings in the Tabular Report ..... 203
Figure 7-16. Selecting a Row Color in the Tabular Report ..... 204
Figure 7-17. Selecting Fonts for the Tabular Report ..... 205
Figure 7-18. Selecting Predicted Markers in the Final Report ..... 205
Figure 7-19. Sample Tabular Data Section in a Report Definition ..... 206
Figure 7-20. The Graph Report Dialog ..... 206
Figure 7-21. Placing a Graph in a Report Definition ..... 207
Figure 7-22. Sizing Graphs in a Report Definition ..... 207
Figure 7-23. The Graph Report Toolbox ..... 208
Figure 7-24. Defining Graph Properties in a Report Definition ..... 209
Figure 7-25. Sample Graph Section in a Report Definition ..... 212
Figure 7-26. The Field Selection Dialog for the Tabular Trend Report Section ..... 214
Figure 7-27. The Field Selection Dialog for the Graphical Trend Report Section ..... 214
Figure 7-28. Sample Trend Section in a Report Definition ..... 215
Figure 7-29. Selecting a Final Report Definition ..... 215
Figure 7-30. Editing a Section of the Final Report ..... 216
Figure 7-92. Selecting the Type of Report to Print ..... 217
Figure 8-1. A Preconfigured Extended Report in Setup View ..... 220
Figure 8-2. A Portion of the Same Preconfigured Extended Report in Preview Mode ..... 221
Figure 8-3. The Reports Options on the Go To Menu ..... 222
Figure 8-4. The Extended Report Editor ..... 222
Figure 8-5. The File Menu Bar ..... 223
Figure 8-6. The Page Menu Bar ..... 223
Figure 8-7. The Toolbox ..... 223
Figure 8-8. The Windows® Bar of the PLUS Program ..... 226
Figure 8-9. Activating the Toolbox ..... 227
Figure 8-10. Selecting the Picture Box Option in the Toolbox ..... 227
Figure 8-11. Dragging the Cursor to Position and Size the Section ..... 228
Figure 8-12. Right-Clicking on Section to View Options ..... 228
Figure 8-13. Selecting a Picture File to Insert ..... 228
Figure 8-14. Inserting and Formatting the Picture File ..... 229
Figure 8-15. The Picture Section Resized and Repositioned ..... 230
Figure 8-16. Selecting the Background Color ..... 230
Figure 8-17. Photograph Section with Colored Border ..... 231
Figure 8-18. Sample Picture Section with Frame and Border ..... 231
Figure 8-19. Creating Shadow for Picture Box ..... 231
Figure 8-20. Copying and Pasting a Section ..... 232
Figure 8-21. Formatting the Text Box ..... 232
Figure 8-22. Sample Text Box with Frame and Border ..... 233
Figure 8-23. The Available Patient Information Fields ..... 233
Figure 8-24. Formatting a Patient Information Field ..... 234
Figure 8-25. Combining Values under a Field Label ..... 235
Figure 8-26. Patient Information Fields in Preview Mode ..... 235
Figure 8-27. Patient Photo Box Setup ..... 236
Figure 8-28. Patient Photo Box in Preview Mode ..... 236
Figure 8-29. Right-click Options for the Tabular Data Section ..... 237
Figure 8-30. Selecting Tabular Data Fields ..... 238
Figure 8-31. Editing Fields in the Tabular Data Section ..... 238
Figure 8-32. Selecting Tabular Data Context Headings ..... 239
Figure 8-33. Editing Context Headings in Tabular Data ..... 239
Figure 8-34. Editing Digits for Percent Contexts in Tabular Data ..... 240
Figure 8-35. The Selected Columns and Fields in Preview Mode ..... 240
Figure 8-36. The User-Defined Field Dialog ..... 241
Figure 8-37. Selecting a User-defined Field ..... 242
Figure 8-38. Fields in Columns Display ..... 242
Figure 8-39. The Tabular Data Column Width Dialog ..... 243
Figure 8-40. Sample Auto-Sized Columns in Tabular Data ..... 243
Figure 8-41. The Formatting Dialog ..... 244

Figure 8-42. Tabular Data Section with No Grid....245
Figure 8-43. Tabular Data Section with Cross Grid....245
Figure 8-44. Tabular Data Section with Full Grid....245
Figure 8-45. Sample Formatted Tabular Data Section....246
Figure 8-46. Menu Options for Challenge Data Section....246
Figure 8-47. Selecting Fields for Challenge Data Section....247
Figure 8-48. The Formatting Dialog for Challenge Data....247
Figure 8-49. Sample Challenge Data Section in Preview Mode....248
Figure 8-50. Formatting Options for the FVC Loop Section....248
Figure 8-51. The FVC Loop Properties Dialog....249
Figure 8-52. Menu of Field Options for the FVC Loop Title....249
Figure 8-53. Selecting the Test Level for the FVC Loop....250
Figure 8-54. Selecting a Challenge Set Number and Effort Number for the FVC Loop Section....250
Figure 8-55. Overlay Options....251
Figure 8-56. Selecting the Volume Scale for the FVC Loop....251
Figure 8-57. Sample Pre-Post FVC Loop Overlay....252
Figure 8-58. The FVC Volume-Time Graph Section....253
Figure 8-59. An FVC Volume-Time Overlay....253
Figure 8-60. Challenge Graph Right-Click Options....253
Figure 8-61. Challenge Graph Properties Dialog....254
Figure 8-62. Changing the Observed Parameter for the Challenge Graph....254
Figure 8-63. Selecting a Baseline Option for the Challenge Graph....254
Figure 8-64. Selecting a PD Algorithm for the Challenge Graph....255
Figure 8-65. Selecting the Graph Scale for the Challenge Section....255
Figure 8-66. Selecting the Axis for the Challenge Graph....256
Figure 8-67. The MVV Graph Section....256
Figure 8-68. MVV Graph Properties....257
Figure 8-69. The MIP/MEP Graph Section....257
Figure 8-70. The MIP/MEP Graph Properties Dialog....258
Figure 8-71. The FRC Graph Section with Right-Click Menu....258
Figure 8-72. The FRC Properties Dialog....259
Figure 8-73. The $N_2$ Washout Graph Section....259
Figure 8-74. The $N_2$ Washout Graph Properties Dialog....260
Figure 8-75. The DL Graph Section with Right-Click Menu....260
Figure 8-76. The DL Properties Dialog....261
Figure 8-77. The Disability Graph Section....262
Figure 8-78. The Disability Data Window in the Disability Graph Section....262
Figure 8-79. The Disability Graph Properties Dialog....262
Figure 8-80. Sample Disability Graph with FVC Overlay....263
Figure 8-81. The Lung Volumes Bar Graph Section with Right-Click Menu....263
Figure 8-82. The Lung Volumes Bar Graph Properties Dialog....264
Figure 8-83. Selecting the Lung Volumes Bar Graph Alignment....265
Figure 8-84. Example of Comparing Predicted and Actual Lung Volumes by Aligning at End-Tidal....265
Figure 8-85. Volume Graph Section Showing BP and SVC Tracing Options....266
Figure 8-86. The Volume Graph Properties Menu....266
Figure 8-87. Examples of Volume Alignment at Test Level (left) and at RV for SVC Test....267
Figure 8-88. Examples of Volume Alignment at Test Level (left) and at RV for Body Box Test....267
Figure 8-89. The Raw Graph Section....268
Figure 8-90. The Raw Graph Properties Dialog....268
Figure 8-91. Sample Raw Graph in Preview Mode....269
Figure 8-92. The Body Box Composite Graph Section....269
Figure 8-93. The Body Box Composite Graph Properties Dialog....269
Figure 8-94. The Body Box Composite Graph Section in Preview Mode....270
Figure 8-95. The Right-Click Options for the Interpretation Section....270
Figure 8-96. The Interpretation Section in Preview Mode....271
Figure 8-97. The Right-Click Menu for the Technician Notes Section....271
Figure 8-98. Sample Notes Section in Preview Mode....272
Figure 8-99. Physician Review Opening Screen....272
Figure 8-100. Opening an Extended Report Definition....273

Figure 8-101. Entering Notes in Physician Review ..... 274
Figure 8-102. Selecting the Type of Report to Print ..... 275
Figure 8-103. Selecting a Report Definition for Printing ..... 276
Figure 9-1. Accessing CPL Diagnostics ..... 277
Figure 9-2. Selecting a Component and Checking the Balloons ..... 277
Figure 9-3. Conditioning the Balloons ..... 278
Figure 9-4. Leak Test Opening Screen ..... 279
Figure 9-5. Conducting a Leak Test ..... 280
Figure 9-6. The Diagnostic History Tab ..... 281
Figure 10-1. Opening Screen of the Predicted Equations Editor ..... 282
Figure 10-2. The Predicted Equations File Menu ..... 282
Figure 10-3. The Predicted Equations Edit Menu ..... 283
Figure 10-4. The Predicted Equations View Menu ..... 283
Figure 10-5. Opening a Predicted Data .xml File ..... 283
Figure 10-6. An Open Predicted Data .xml File ..... 284
Figure 10-7. The Predicted Equation Editor ..... 284
Figure 10-8. The Predicted Equation Script Editor ..... 286
Figure 10-9. Accessing the Predicted Equation Protocol Editor ..... 287
Figure 10-10. The Predicted Equation Protocol Editor ..... 287
Figure 10-11. The Predicted Protocol Equation Selector ..... 288
Figure 10-12. Age Ranges in Predicted Protocols ..... 289
Figure 10-13. Reference to the *Collins* Protocol as Consisting of Derived Equations ..... 290
Figure 10-14. Example of a Derived Equation in the Script Editor ..... 291
Figure 10-15. Final Derived Equation Saved in the .xml file ..... 291
Figure 10-16. The Use of Functions in Predicted Equations ..... 292
Figure 10-17. Function Mean() Displayed in the *Predicted* Field of the Equation Editor ..... 293
Figure 10-18. Pressing the *Test* Button for the Selected Equation ..... 293
Figure 10-19. The Predicted Equation Test Dialog ..... 294
Figure 10-20. Clicking on the Calculate Button in the Predicted Equation Test Dialog ..... 295
Figure 10-21. Using the Script Editor in the Equations Test Dialog ..... 296
Figure 10-22. Selecting the Predicted Tab in the Database Utilities Option ..... 297
Figure 10-23. Selecting an .xml File from which to Import Predicteds ..... 297
Figure 10-24. Selecting Equations and/or Protocols for Import into the Current PLUSDB Database ..... 298
Figure 10-25. Selecting Predicted Equations and/or Protocols for Export to an .xml file ..... 299
Figure 10-26. Selecting a Destination .xml file for Predicteds Export ..... 299
Figure 10-27. Status of Predicteds Export Displayed ..... 299
Figure B-1 Lung Volumes and Capacities ..... 305
Figure B-2. Cross-Section of the Breathing Circuit in a Basic Spirometer ..... 308
Figure C-1 Predicted Equation Authors for the PLUS/2000 Protocols ..... 315
Figure D-1. Flow Chart of the Extended Ellis Interpretation Program ..... 329

# SECTION ONE --GETTING STARTED

## System Description

The Collins PLUS/2000 system is a collection of software and instrumentation that allows the user to conduct Pulmonary Function Testing (PFT), Cardiopulmonary Exercise testing, and Body Plethysmography testing. Depending on your PLUS system's testing devices, certain test procedures in this manual may or may not apply.

PLUS software is run under the Windows® operating system and is operated like any other Windows® program. For example:

a. The PLUS program is accessible from the desktop
b. The Help program operates similarly
c. Files are opened and saved using similar icons or commands
d. Holding the mouse pointer over an option without clicking on it will produce a description of that option. I
e. If the text in a window is not completely visible, that is, if there is more than will fit in the screen, clicking on the up or down scroll arrows will advance the text on the screen.

Learning to run Windows® will teach you the basics of running the PLUS program. If you are not familiar with Windows®, refer to your Windows® Manual or Windows® Help program for more details.

## System Requirements

Collins PLUS/2000 system requirements are as follows:

1. Intel Pentium® II based PC (350 MHz or greater. Intel Celeron-based systems are not acceptable.)
2. 800 x 600 resolution, 16 bit color graphics subsystem minimum
3. 128 MB RAM (minimum)
4. 3 GB Hard drive (minimum - 2 GB available disk space.) (6 GB if a dual operating system)
5. MS Windows® 2000 Professional (Version 5.0, Build 2195 or later) installed on computer. If computer has Windows® 98 installed it must be completely removed and a full version of Windows® 2000 installed. (DO NOT UPGRADE 98 to 2000).
6. One available ISA bus socket for standard Collins I/O card set to address 310h, IRQ 5, wait state ON.
7. A Windows® 2000 compatible printer must be installed on system.
8. USB (Universal Serial Bus) ports for camera, printer and any Collins devices that require such ports. (Number required depends on system configuration.)

## Documentation

1. There are two manuals for the PLUS/2000 system:

   a. The hardware manual, which describes the physical equipment in the system. There is a hardware manual for each of the CPL and the Body Plethysmograph systems. The hardware manual covers such topics as system installation, powering up and down, maintenance and troubleshooting.

   b. The PLUS/2000 software manual, which you are now reading, describes the operation of PLUS/2000 software.

2. In addition to this manual, you may navigate the on-line help system for the Collins PLUS/2000 system. This operates the same way as any standard Windows® Help system. You may look topics up in the Table of Contents, Index, or in the Search mode.

3. To access the help system, once you have powered up, click on Help from the Main Menu at the top of the screen, then on PLUS/2000 Help Topics.

4. You may also access the Collins Web site by clicking on Help, then on Collins Medical on the Web.

## Technical Support

For technical support, click on Help, then Obtaining Technical Support.

Or…

Call 800-635-3200

Or 781-843-0610 and ask for the Customer Support Services Department.

## Powering up the System

Refer to Section One of the CPL Manual for directions on powering up the system.

## Accessing the PLUS Program

1. At the Windows® Desktop, click on the Start button at the bottom left corner of the screen, then on Programs. From the Programs menu, select the Collins PLUS/2000 option. Alternately, if you have created a shortcut icon for the PLUS/2000 program on the Desktop using the Windows® *Create Shortcut* option, double-click on this icon.

2. The opening screen of the PLUS program will display. As the program is accessed, the disk drive "in-use" light on the computer front panel will come on, indicating that the hard disk is being used. (Note: not all computers have the in-use light.)

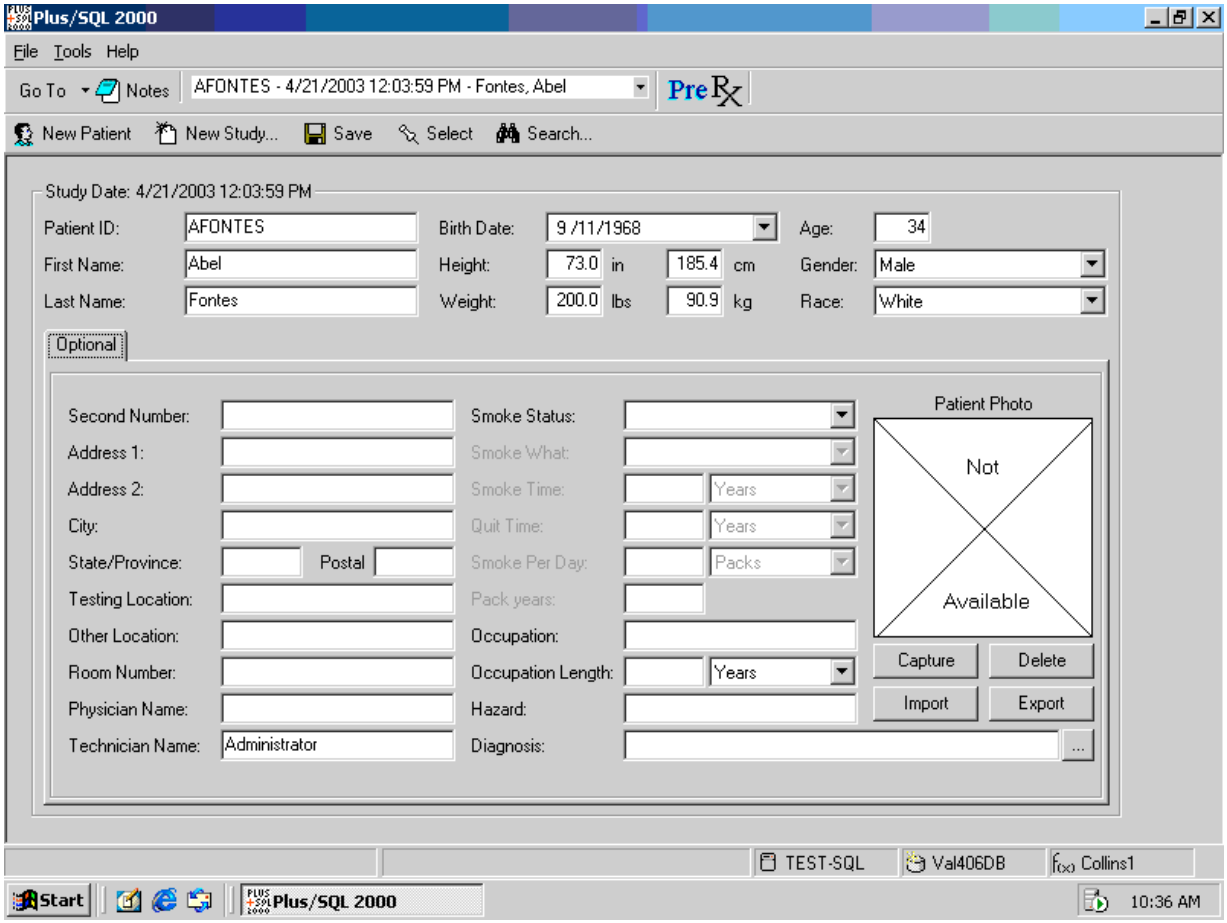



Figure 1-1. The PLUS/2000 Opening Screen

## Getting Around the PLUS Program

1. The PLUS/2000 program will display three menu bars at the top of the screen. From top to bottom these are the:

   *Windows menu*
   *GoTo menu*
   *Test menu*

2. The **Windows menu**, which will be described later in this manual, consists of the following:

   *File  Tools  Help*

3. The **GoTo menu** consists of the following options:

   *GoTo  Notes  Patient Cache  Pre/Post Rx control*

4. The *GoTo* button is the place from which you may access the major portions of the PLUS program. When you click on this option, the following menu displays:

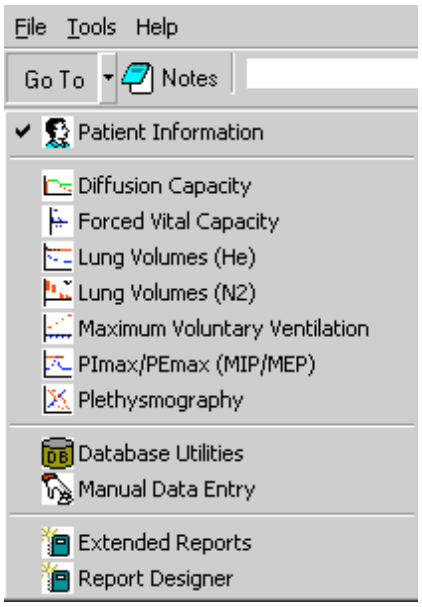



Figure 1-2. The GoTo Menu

5. *Notes* allows you to enter notes on the current patient study.

6. The *Patient Cache* is a drop-down window that contains a subset, from the full patient database, consisting of the patient studies that are currently being worked with.

   A patient study is automatically entered into the patient cache when you create, update or select a study in Patient Information.

   In the Reports program, you use the patient cache to select or preview one or more patient studies for final report writing. You may also direct the program to remove the study from the cache once the report has printed.

   The *Cache Management* program, available from Tools, allows you to determine what studies are to be in the cache, provided you have the required permissions.

7. The *Pre/Post Rx* control allows you to choose between Pre-, Post-drug, and Challenge testing modes.

8. Each of these options will be described in further detail in this manual.

9. The Test Menu contains the menu for the current portion of the PLUS program. When you first access PLUS/2000, the Patient Information screen is current.

10. The ***Patient Information*** screen allows you to create a patient study for the current patient, which is the first step in beginning the test procedure. This is described in the *Patient Information* Section.

## Screen Messages

1. Messages about what is going on in the program may be found in three message bars on the screen:

   a. PLUS Status bar, to the right of the Pre/Post Rx Control on the GoTo bar
   b. The two System Status bars below the main window.

2. Look at these areas frequently for information about the program. Error messages will also appear on the screen in pop-up windows.

## Installation Procedure for Collins Plus/SQL 2000 Software Versions 4.04 – 4.07

**NOTE:**

The following instructions apply to installing Plus/SQL 2000 versions 4.04 through 4.07. However, for the sake of simplicity, 4.07 will be the version referred to throughout this discussion.

### Uninstalling Existing PLUS Software

Prior to running the Setup Wizard to install Collins Plus/SQL 2000 version 4.07 software, any existing Collins Plus/SQL 2000 (Plus2k) software that may already be installed on the system must be uninstalled.

1. To uninstall an existing copy of Plus2k, close the program if it is running. Click on the **Start** button and select **Settings\Control Panel\Add/Remove Programs**.

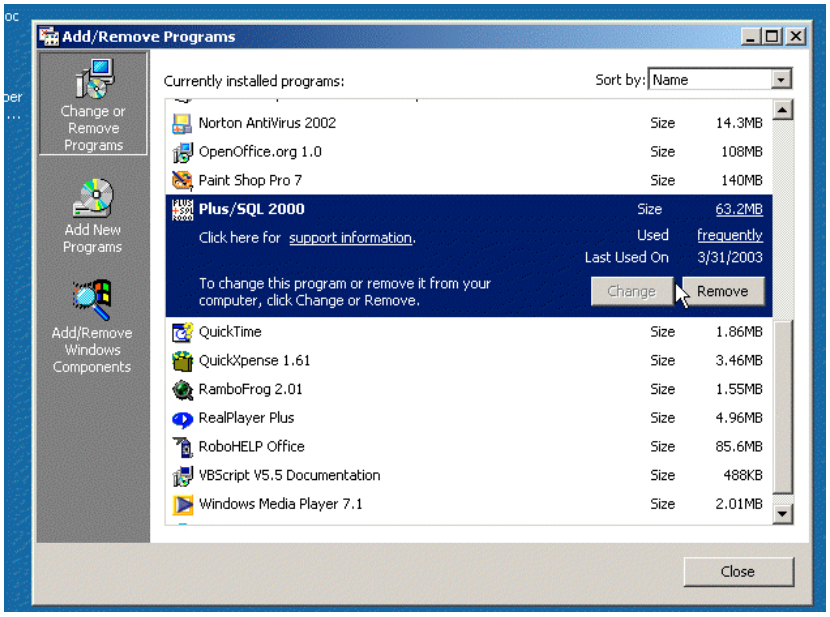

Add/Remove Programs
Change or Remove Programs
Add New Programs
Add/Remove Windows Components
Currently installed programs:
Sort by: Name
Norton AntiVirus 2002 Size 14.3MB
OpenOffice.org 1.0 Size 108MB
Paint Shop Pro 7 Size 140MB
Plus/SQL 2000 Size 63.2MB
Click here for support information.
Used frequently
Last Used On 3/31/2003
To change this program or remove it from your computer, click Change or Remove.
Change
Remove
QuickTime Size 1.86MB
QuickXpense 1.61 Size 3.46MB
RamboFrog 2.01 Size 1.55MB
RealPlayer Plus Size 4.96MB
RoboHELP Office Size 85.6MB
VBScript V5.5 Documentation Size 488KB
Windows Media Player 7.1 Size 2.01MB
Close

Figure 1-3. The Add/Remove Programs Dialog

2. On the Add/Remove Programs dialog window, find and click on Plus/SQL 2000 to select it. Plus/SQL 2000 will be highlighted. Click on the Remove button. Clicking the Remove button will display a dialog asking if you're sure you want to remove Plus/SQL 2000. Click yes to begin the Uninstall procedure.

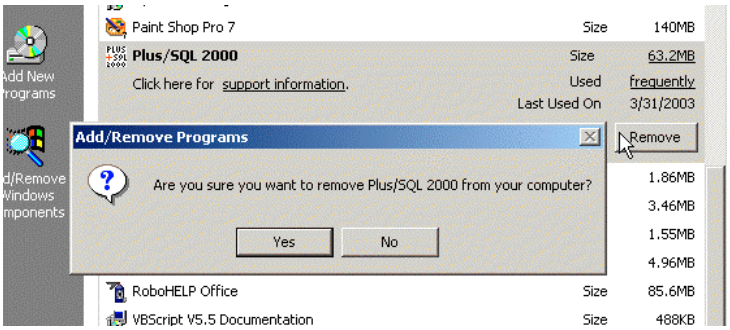



Figure 1-4. Selecting Yes to Begin the Uninstall Procedure

3. The Add/Remove program will uninstall Plus2k. A series of bar graphs indicating the progress of the Uninstall procedure will be displayed. Once started, the process will proceed automatically. When completed, all dialogs windows will be cleared, leaving the Add/Remove Programs dialog window as the active window.

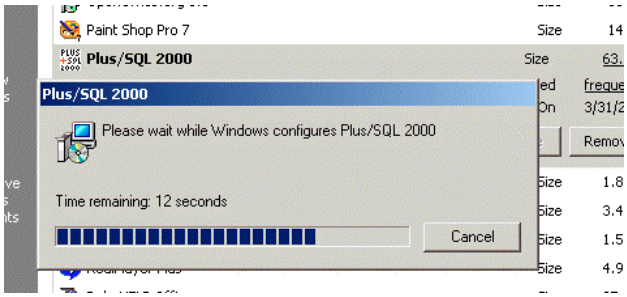



Figure 1-5. Window Indicating Progress of Uninstall Procedure

4. When the Uninstall process is completed, the Add/Remove program dialog will no longer display Plus/SQL 2000 in the list of installed programs. Click on the Close button to exit the Add/Remove program.

5. Close the Add/Remove Programs dialog window. Open Explorer by right-clicking on the Start button at the left of the task bar (usually located at the bottom of the screen.) Left-click on Explorer. In the large left pane that displays a listing of folders on the hard disk, click on the '+' sign in front of **Program Files**. Look through the listing of folders under Program Files for a folder named *Collins Medical*. If it exists, click on the folder icon to select it (icon should change to an opened file folder); then, with the pointer on that icon, right-click to bring up the context menu. Click on *Delete* to delete the folder. A dialog will be displayed telling you that the folder and everything in will be deleted and asking if you want to do this. Click *Yes* to delete the folder. Close Explorer by clicking on the X in the upper right corner.

**Plus2k Program Setup (Installation)**

1. Place the Plus/SQL 2000 v4.07 Setup CD-ROM in the CD-ROM drive and close the drawer. If the disk is already in the drive, open the drawer and re-close it to force the reading of the Autorun file. The Setup program will be started and the Installation Language dialog will be displayed as shown below.

Installation Wizard
Plus/SQL 2000
Installation Language
Welcome to the Plus/SQL 2000 Installation Wizard. Please select your installation language from the list of supported languages below. Click Next to continue.
English (United States)
English (United Kingdom)
Italian (Italy)
Close
< Back
Next >
Install

Figure 1-6. The Installation Language Dialog

*Notes on Plus/SQL 2000 Languages*

- The PLUS program currently supports three languages, US English, UK English and Italian. US English is the default language for the PLUS program. More languages will become available as the need for them increases.

- The PLUS/2000 program properly handles issues dealing with local use of commas, periods, etc. For example, the use of commas and decimals in numbers is reversed accordingly (e.g.; ten thousand written out numerically would read 10,000 in the US but 10.000 in Italy).

- The desired language must be selected at two different phases of installation:

    - during the *Installation Wizard* (you are at this point now)
    - during the *Database Installation Wizard* (described further on in this discussion)

- If you select one of the alternative languages, it will be installed as the current language and supercede the default, which is the built-in US English.

- At installation, the program installs the selected language file. If the selected language file is not found or is not readable (in cases where they were moved or are otherwise not available) PLUS defaults to US English, which is embedded into the PLUS2000 program.

- The language selected in the Installation Wizard will determine the language of the subsequent tools and components selected in the Installation Wizard, such as Microsoft Data Access Components and the PLUS program.

2. Click on the icon for the desired language to select it, and then click the Next button at the bottom of the dialog window. The Component Installation dialog window will be displayed.

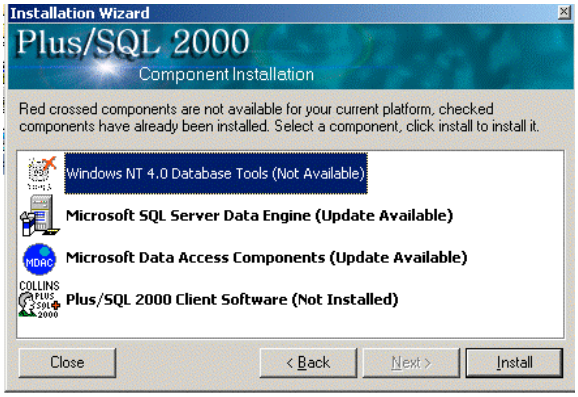

Installation Wizard
Plus/SQL 2000
Component Installation
Red crossed components are not available for your current platform, checked components have already been installed. Select a component, click install to install it.
Windows NT 4.0 Database Tools (Not Available)
Microsoft SQL Server Data Engine (Update Available)
Microsoft Data Access Components (Update Available)
Plus/SQL 2000 Client Software (Not Installed)
Close
< Back
Next >
Install

Figure 1-7. The Component Installation Dialog

*Notes on Component Installation*

- The Component Installation list contains the following type of information:

- Options that are not available for installation within the current context
- Components that have upgrades available
- Main program components and their Installed/Not Installed status.

- Options not available for installation will have a red X mark over the corresponding icon to the left. Options that have been installed will have a green check mark on the corresponding icon. Options for which there is an update available in the new software installation will have the words *Update Available* in parenthesis.

- To initiate installation of an available option, highlight the desired component by left-clicking on it; then click *Next*. When installation is completed, the selected option will be marked Installed and a green checkmark will be displayed on the icon.

- If you have more than one component to update or install, you must run the installation program for each of these items.

3. Depending on the last version of software loaded onto your system, the entries, *Microsoft SQL Server Data Engine* and/or the *Microsoft Data Access Components* may display in parenthesis the message *Installed* or *Update Available*. These are Microsoft database support files and may need to be upgraded as new Plus2k versions are released. The setup program checks the installed version (if any) and determines if an update should be loaded. In the dialog window above, both files indicate that Updates are available. In general, install items in the order they are listed.

4. Click on the second entry, Microsoft SQL Server Data Engine, to select it and then click on the Install button to the lower right of the dialog. The dialog displayed below will pop up on the screen.

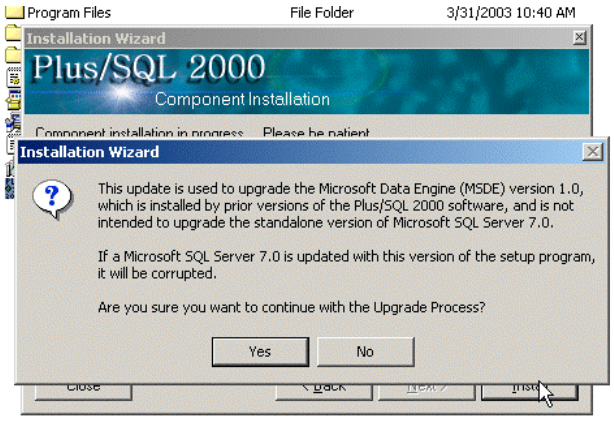

Program Files
File Folder
3/31/2003 10:40 AM
Installation Wizard
Plus/SQL 2000
Component Installation
Component installation in progress. Please be patient.
Installation Wizard
This update is used to upgrade the Microsoft Data Engine (MSDE) version 1.0, which is installed by prior versions of the Plus/SQL 2000 software, and is not intended to upgrade the standalone version of Microsoft SQL Server 7.0.
If a Microsoft SQL Server 7.0 is updated with this version of the setup program, it will be corrupted.
Are you sure you want to continue with the Upgrade Process?
Yes
No
Close
< Back
Next >
Install

Figure 1-8. Upgrade Dialog for Data Engine

5. Unless you have the complete Microsoft SQL 2000 Database Enterprise Management software installed on your system (not common) click Yes to continue the upgrade process.

6. A dialog box will be displayed indicating the progress of the upgrade procedure. Depending on the speed and configuration of your system, this upgrade procedure may take several minutes. Even though the Time Remaining bar graph does not seem to move for long periods of time, you will note that the hard drive activity light on the front of your computer indicates that the program is still running.

7. When the upgrade procedure is completed, a dialog window displays a message telling you that the computer must be restarted for the changes to take effect. We'll restart the computer later, so for now click on the No button.

8. Clicking the No button will close the restart dialog window, revealing the Component Installation dialog with the Microsoft SQL Server Data Engine option status updated to *Installed*.

Installation Wizard
Plus/SQL 2000
Component Installation
Red crossed components are not available for your current platform, checked components have already been installed. Select a component, click install to install it.
Windows NT 4.0 Database Tools (Not Available)
Microsoft SQL Server Data Engine (Installed)
Microsoft Data Access Components (Update Available)
Plus/SQL 2000 Client Software (Not Installed)
Close
< Back
Next >
Install

Figure 1-9. Component Installation Dialog Showing Data Engine Installed

9. If the Microsoft Data Access Components selection indicates that an Upgrade is available, click on that option to select it and then click on the Install button. An End-User License agreement will be displayed. Click on the check box to the left of the *I accept all the terms of the preceding license agreement*. The Next button will become active; click on it to start the upgrade procedure.

10. An Installing the Software dialog window will be displayed. Click on the Finish button to begin the upgrade procedure.

11. At the completion of the upgrade procedure, a Setup is Complete dialog message will be displayed. Click on the Close button to clear the dialog window.

12. The dialog window will close, exposing the Plus2k Component Installation dialog again. The status of the Microsoft Data Access Components option will be updated to *Installed* and a green check mark will be displayed on the icon to the left.

13. Click on the last entry, Plus SQL 2000 Client Software, to select it and then click on the Install button.

Installation Wizard
Plus/SQL 2000
Component Installation
Red crossed components are not available for your current platform, checked components have already been installed. Select a component, click install to install it.
Windows NT 4.0 Database Tools (Not Available)
Microsoft SQL Server Data Engine (Installed)
Microsoft Data Access Components (Installed)
Plus/SQL 2000 Client Software (Not Installed)
Close
< Back
Next >
Install

Figure 1-10. Selecting the PLUS Software Option to Install

14. The Plus/SQL 2000 Installation Wizard welcome screen will be displayed. Click on the Next button.

Plus/SQL 2000 Setup
Welcome to the Plus/SQL 2000 Installation Wizard
It is strongly recommended that you exit all Windows programs before running this setup program.
Click Cancel to quit the setup program, then close any programs you have running. Click Next to continue the installation.
WARNING: This program is protected by copyright law and international treaties.
Unauthorized reproduction or distribution of this program, or any portion of it, may result in severe civil and criminal penalties, and will be prosecuted to the maximum extent possible under law.
< Back
Next >
Cancel

Figure 1-11. The Plus/SQL 2000 Installation Wizard

15. The Plus/SQL 2000 end-user license agreement will be displayed. Scroll to read the entire license agreement. Then click on the white circle to the left of the *I accept the license* agreement statement. Click on the Next button.

16. The User Information dialog will be displayed. Enter an appropriate user name and organization name. Click the Next button to continue.

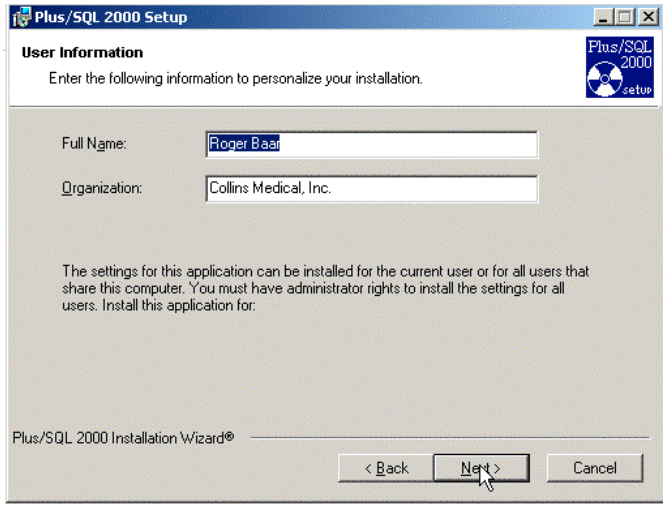

Plus/SQL 2000 Setup
User Information
Enter the following information to personalize your installation.
Plus/SQL 2000 setup
Full Name:
Roger Baar
Organization:
Collins Medical, Inc.
The settings for this application can be installed for the current user or for all users that share this computer. You must have administrator rights to install the settings for all users. Install this application for:
Plus/SQL 2000 Installation Wizard®
< Back
Next >
Cancel

Figure 1-12. The User Information Dialog

17. The Select Features dialog will display. Plus/SQL 2000 will be selected by default and the default location on the hard drive for storing the Collins Plus2k program will appear in the *Current Location* frame. Unless you have an extensive knowledge of computers and the Plus2k software details, accept the default entries by clicking the Next button.

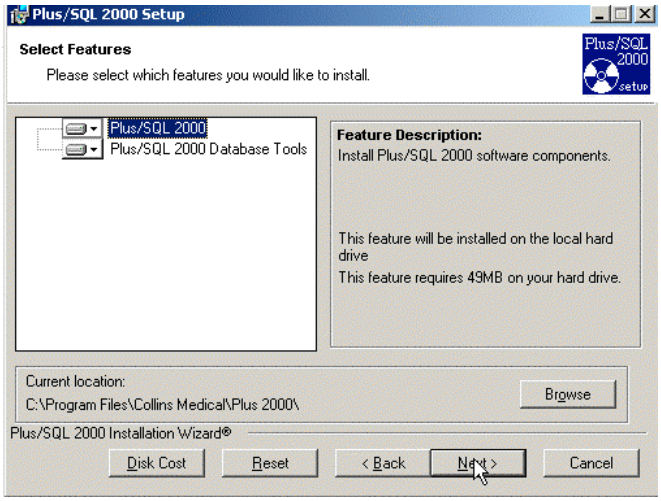



Figure 1-13. The Select Features Dialog

18. The *Ready to Install the Application* dialog will display. This dialog provides an opportunity to back up and correct or change entries if desired, or to cancel the Installation program. Click the Next button to begin installation.

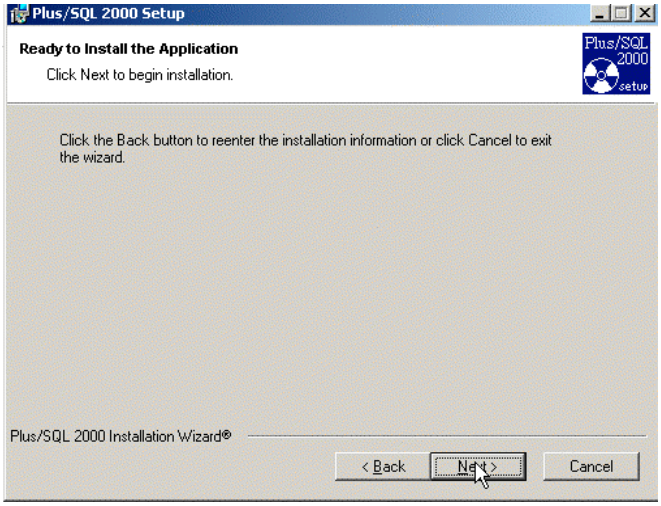

Plus/SQL 2000 Setup
Ready to Install the Application
Click Next to begin installation.
Plus/SQL 2000 setup
Click the Back button to reenter the installation information or click Cancel to exit the wizard.
Plus/SQL 2000 Installation Wizard®
< Back
Next >
Cancel

Figure 1-14. The *Ready to Install Application* Dialog

19. The Upgrading System progress indicator dialog will be displayed. A series of rapidly changing messages above the progress bar graph will indicate the steps of the installation procedure as they occur. The progress bar graph will indicate the status of the procedure and the approximate time remaining.

20. A dialog will be displayed when the installation procedure has successfully completed. Click the Finish button to clear the completion dialog window.

21. The Component Installation dialog will be revealed again. The Plus/SQL 2000 Client Software selection will be updated to indicate *Installed* and a green check will be displayed on the icon to the left.

Installation Wizard
Plus/SQL 2000
Component Installation
Red crossed components are not available for your current platform, checked components have already been installed. Select a component, click install to install it.
Windows NT 4.0 Database Tools (Not Available)
Microsoft SQL Server Data Engine (Installed)
Microsoft Data Access Components (Installed)
Plus/SQL 2000 Client Software (Installed)
Close
< Back
Next >
Install

Figure 1-15. Component Installation Dialog Showing PLUS Software Installed

22. Click on the Close button to dismiss the Installation Wizard. All necessary options have now been installed. Recall that when the Microsoft SQL Server Data Engine was upgraded, a message was displayed stating the computer must be restarted for the changes to take effect. Close all open programs and return to the desktop. Click the Start button and select Shutdown/Restart to restart the computer. When the computer has rebooted, log back in as appropriate.

**Installing a New Database**

If this is a new installation, a fresh Plus2k, version 4.07 database must be installed, using the Plus 2000 Database Installation Wizard. Instructions for these procedures follow.

1. Click on the Start button to the left of the task bar. Select Programs/Plus 2000/Database Setup Wizard to start the database

setup program. The database language selection dialog will be displayed. The language selected here should be the same language selected in the Installation Wizard, above. Click on the white button in front of the desired language. Then click on the Next button.

Figure 1-16. The Database Language Selection Dialog

2. The dialog will change to show the default locations for the main database related files. Accept the defaults by clicking the Next button.

Plus/SQL 2000
Database Installation Wizard
Microsoft SQL Server already installed.
The Database Setup Wizard has determined that Microsoft SQL Server 7.0 or higher or the Microsoft Data Engine 1.0 or higher is installed.
MSDE Install Folder
C:\MSSQL7\
MSDE Data Folder
C:\MSSQL7\
Help
Cancel
< Back
Next >
Finish

Figure 1-17. Default Locations for Database Files

3. A database information dialog will be displayed. Enter a unique database name (the default database name for a new installation with no Plus2k databases installed is PlusDB.) Enter a password. (The password is case insensitive so either upper case or lower case letters and numbers are acceptable.) Enter a Hospital ID. Click on the Next button to proceed.

Figure 1-18. Database Information Dialog

4. The Setup Start dialog will be displayed. It is possible to back up to correct or change data before proceeding. Assuming the database name, password, and hospital ID are set as desired, click on the Finish key to initiate creation of the database.

Figure 1-19. The Database Start-Setup Dialog

5. A dialog informing you that the operation may take several minutes will be displayed. The length of time required to create a new database is dependent on the computer speed among other factors. Click on the OK button to proceed with database creation.

6. A dialog window indicating the progress of the database creation will be displayed. When the database creation is completed a dialog window stating that the database installation was successful will be displayed. Click OK to clear the dialog windows and terminate the database setup program.

**Backing Up Existing Databases Prior to Upgrading**

1. If there is one or more existing Plus2k databases on the system, they must be upgraded to version 4.07 in order for Plus2k v4.07 to connect to them and read the data they contain. Prior to upgrading any databases, use the Plus 2000 Database Backup Wizard to create a backup of each database to be upgraded. The steps for backing up a database are given below:

**IMPORTANT**:
*All databases should be backed up prior to upgrading them to a later version. Failure to back up a database may result in loss of all data, should anything go wrong during the upgrade procedure.*

2. To back up a database, click on the *Start* button to the left of the taskbar (usually at the bottom of the computer screen). To start the backup wizard, select Programs, then Plus 2000, then Database Backup Wizard. The backup wizard will display a listing of all available Plus2k databases.

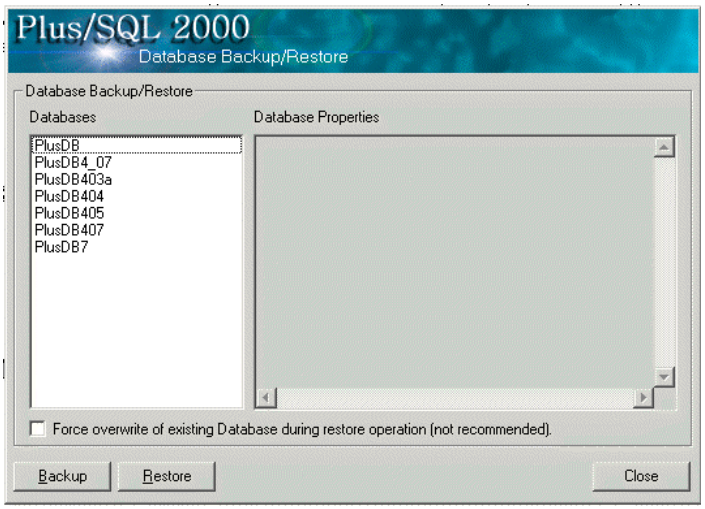



Figure 1-20. The Database Backup/Restore Dialog

3. Select the database you wish to backup by clicking on it. The selected database will be highlighted and information about the database will be displayed in the Database Properties pane to the right of the dialog window.

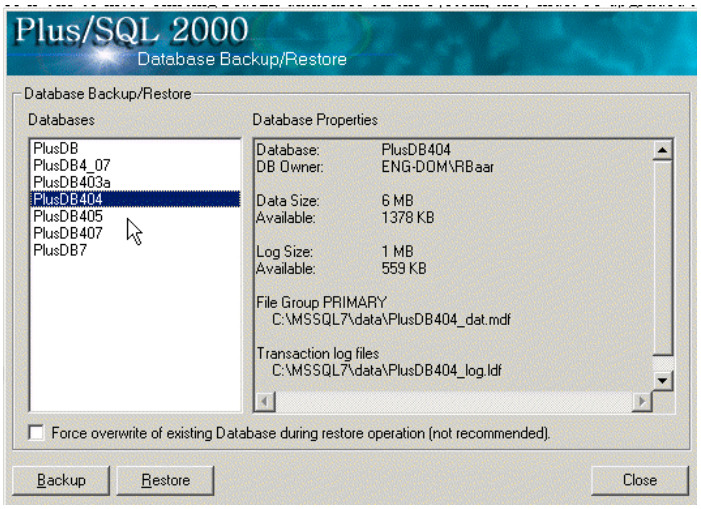



Figure 1-21. Selecting the Database to Back Up

4. Click on the Backup button to begin the backup process. A Save backup file dialog will be displayed. The database will be saved in the folder listed in the *Save in* text box. You may click the downward pointing arrow at the right of the *Save-in* text box to select a different destination folder. Once the desired destination folder is shown in the *Save-in* text box, enter a filename for the database backup file in the *File name* text box. Then click on the Save button. The backup process will begin and progress will be indicated by a progress bar graph at the bottom of the Database Backup/Restore dialog window.

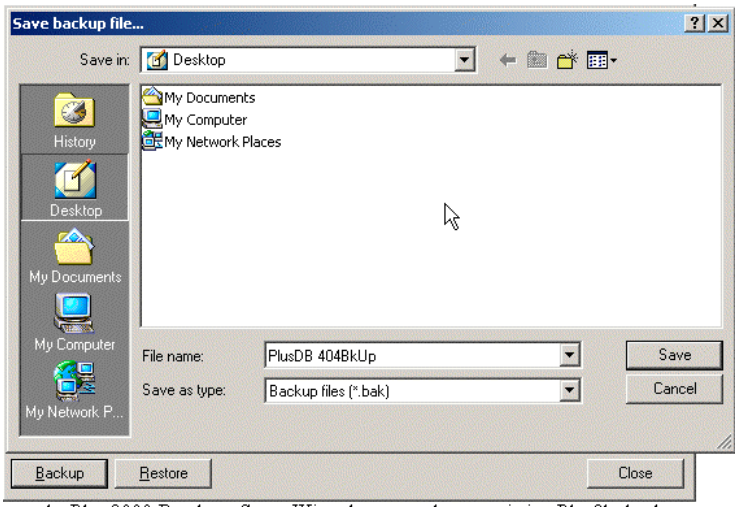



Figure 1-22. The Save Backup File Dialog

5. When the backup process is completed, a Backup completed dialog message will be displayed. Click on OK to clear the completed dialog message and then on the Close button to terminate the Database Backup/Restore Wizard. The backup file with the name you selected and a .bak extension will exist in the destination folder you selected. Protect this file. You will need it to restore the database if anything should go amiss during the database upgrade procedure.

*Notes on the Database Backup Wizard*

- The Database Backup Wizard will allow you to perform a manual, attended backup of your database, in which the wizard leads you through the steps. Alternatively, a script can be started by the Windows® 2000 Scheduling Agent that will perform scheduled, unattended backups of selected Plus 2000 databases.

- The Database Backup Wizard does not provide for remote backups and the backup program must be run from the computer on which the database is located. That is, if the database is located on a server, the backup must be run from the server, or if the database is located on the local testing system, the backup must be run from the local computer. The

Database Backup Wizard selection will not appear on the Plus 2000 menu of any system in which a database has not been installed.

- To restore the database from a previously saved backup file to the original database, use the ***Restore*** function.
- Selecting *RESTORE* will bring up the *OPEN*...dialog in which the user will select the location and filename of a previously saved backup file.
- Click the *OPEN* button to execute the restore operation. The program will ask if you wish to restore the particular database from the selected file. Click Yes. A message will be displayed indicating the success or failure of the restore operation.

**Upgrading an Existing Database**

1. Any existing databases for Plus2k version prior to v4.07 must be upgraded before they can be used by Plus2k v4.07. To upgrade a database, be certain you have a backup of the database. Then click on the Start button at the left of the task bar. Select and run Programs/Plus 2000/Database Setup Wizard to perform the upgrade procedure. The procedure will begin by displaying the Database Language selection dialog. Click on the desired language, and then click on the Next button.

Figure 1-23. The Language Selection Dialog for Database Upgrade

2. The language selection dialog will be replaced by the Database Files location dialog. Accept the default displayed and click on the Next button.

Plus/SQL 2000
Database Installation Wizard
Microsoft SQL Server already installed.
The Database Setup Wizard has determined that Microsoft SQL Server 7.0 or higher or the Microsoft Data Engine 1.0 or higher is installed.
MSDE Install Folder
C:\MSSQL7\
MSDE Data Folder
C:\MSSQL7\
Help
Cancel
< Back
Next >
Finish

Figure 1-24. The Files Location Dialog for the Database Upgrade

3. The default database file location dialog will be replaced by the database information dialog. Click on the Upgrade existing database checkbox to select this option. Enter the name of the database you wish to upgrade. Then enter the database password and click the Next button.

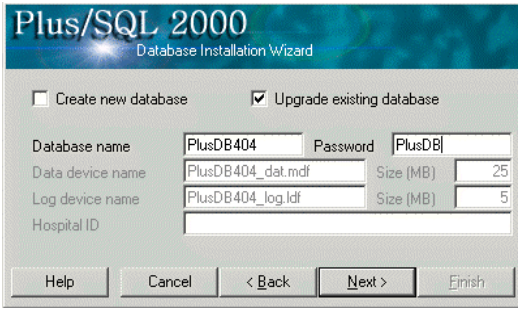



Figure 1-25. The Database Information Dialog for Database Upgrade

4. A warning regarding the need to backup a database before upgrading it will be displayed. If you have made a current backup of the database, click the No button, otherwise click the Yes button to quit the upgrade routine and backup the database before restarting the Upgrade wizard.

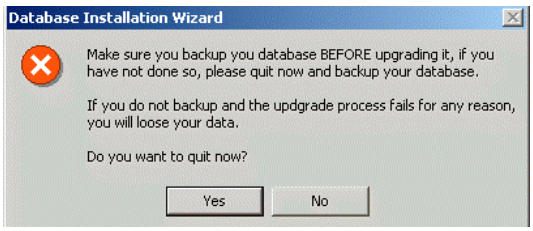

Database Installation Wizard
Make sure you backup you database BEFORE upgrading it, if you have not done so, please quit now and backup your database.
If you do not backup and the updgrade process fails for any reason, you will loose your data.
Do you want to quit now?
Yes
No

Figure 1-26. Backup Warning Screen for Database Upgrade

5. The Start upgrade dialog is displayed. Click on the Finish button to proceed.

Figure 1-27. The Start Upgrade Dialog for Database

6. The backup warning dialog will be displayed once more. This is the last chance to backup the database prior to starting the upgrade procedure. ***If the database you are about to upgrade contains data that is important to you, it is crucial that you have a current backup of the database you are going to upgrade. If any problems occur during the upgrade procedure, e.g. computer malfunction, loss of power, etc. you must have a current backup or the data is irretrievably lost.*** If you are ready to begin the upgrade process, click on the No button to begin.

7. The database upgrade will proceed automatically. A progress dialog will be displayed during the upgrade procedure. At the successful completion of the upgrade, an *Installation completed successfully* dialog will be displayed. Click on the OK button to clear this dialog, and then click on the Finish button to close and dismiss the Upgrade Wizard. The database just upgraded can now be accessed by Plus2k v4.07. Repeat this process for each database you wish to upgrade.

## SECTION TWO -- ENTERING PATIENT INFORMATION AND CREATING STUDIES

### About Patient Studies

1. In order to test a patient, a study with a unique filename must be created for that patient. To select a patient from among those already created, select the Search option at the top of the Patient Information screen.

2. If testing a particular patient for the first time, you must create a study for that patient by entering information in the Patient Information screen. Also, if you wish to create a new study for a patient already in the database, you must use this program. Each study has a unique date and time.

3. Predicted values are based upon patient data; it is therefore important to enter the information in the format indicated and as accurately as possible. It is also important to be consistent in the way you enter data, because at some point you may want to retrieve information from the database.

4. In many instances, the responses to questions asked in the Patient Information program are set; you just have to select them. For these types of responses, consistency is ensured. However, some answers are open, meaning the user types in the information. For example, one question asked is Physician. Let's suppose that your Lab has been entering both Brown and Dr. Brown for Physician and that at some point in the future you wish to retrieve all the patients of Dr. Brown for a particular study. If you were to unknowingly request the studies under just Brown or just Dr. Brown, you would retrieve only part of the studies you were looking for.

5. Likewise, if you are a technician and at some point wish to retrieve all the studies conducted by you, it is essential to enter your name consistently all the time. If you enter it as Robert once, then it must always be entered as Robert. Bobby, Bob and Robert all look different to the computer.

6. Laboratory personnel must agree upon the precise answers that can be entered for various open data lines, such as “patient location”, and “other location”, so that consistency may be assured.

### Creating a Patient Study

1. If testing a particular patient for the first time, you must create a study for that patient by entering information in the Patient Information program. Also, if you wish to create a new study for a patient already in the database, you must use this program. Each study has a unique date and time.

2. On the Main Screen, click on the Go To arrow. Then click on the Patient Information option. The Patient Information Screen, with all the fields to fill in, will display. The upper half of the table requests the minimal amount of information needed to create a patient study. The lower half of the screen contains tabs for optional information.

3. There are two types of information that may be entered. One is an open field, where you type in the requested information, using up to the number of characters allowable by the program. The other type is the field with a down arrow at the end. You view the available selections by clicking on this arrow. You then click on an option to select it. In order to assure consistency when typing in information in the open fields, refer to the discussion in About Patient Studies.

4. The information fields are listed and described below. Press the Tab key to move from field to field.

   **Patient ID:** Enter the desired ID number for your new patient. This number will now display in the Patient ID line.

**NOTE:**

Keep in mind that if you decide to change the Patient ID number in this program, it will erase from the screen any information entered for the patient under the previous ID number. Every time a Patient ID is entered into this field, a database search is conducted. If the patient exists in the database, the information is retrieved and displayed. If the patient does not exist in the database, the system clears the data entry fields. In order to change the patient ID and retain the same information, refer to Changing the Patient ID.

When you press the Tab key to advance to the *First Name* field, a window will pop up directing you to enter the Study Date. The current date is given as the default. If this is acceptable, click on OK.

To enter another date, click on the displayed date and type in the desired study date in the format MM/DD/YYYY, for example, 03/29/2002 (or DD/MM/YYYY, 29/03/2002, if you have selected the European date format in Configure). Be sure to enter the year in four digits (e.g., 2002 instead of just 02).

Alternatively, you may enter the date by clicking on the down arrow next to the displayed date and making selections from the drop-down calendar. On this calendar, the current date will be circled in red and the selected date you make will be shaded.

To adjust the month ahead or back, click on the side arrows next to the displayed month. Alternatively, click on the displayed month to get a drop-down list of months. Then point to and click on the desired month.

To change the year, click on the displayed year and then on the up or down arrows to adjust the year forward or back.

To change the day, point to and click on the desired day on the drop-down calendar.

When changes to the date are complete, click on OK.

**First Name:** Enter the first name of your patient in as many characters as allowed. Then press the Tab key.

**Last Name**: Enter the last name of your patient in as many characters as allowed.

**Date of Birth:** Enter the patient's birthdate in the same format and using the same methods as described for the Study Date, above.

**Age:** As soon as you have pressed the Tab key after entering the birthdate, the patient's age is calculated and displayed next to the birthdate as in the following example:

**Date of Birth:** 07/16/1954 Age 48

**NOTE:**

Always check afterwards to make sure that you have entered in a correct and valid birth date.

**Height:** Enter patient's height in English or metric units (e.g. 64 inches). Decimals may be used. Note that when you enter the height and weight in English units, the equivalent measurements are displayed in metric units as well and vice-versa.

**Weight:** Enter the patient's weight in English or metric units (e.g. 110 lbs).

**Gender:** Click on the down arrow and select Male or Female, or type M or F on the keyboard.

**Race:** Clicking on the box next to this field will produce a drop-down list of race/ethnicity categories. Select the desired race or ethnicity from the list. The default list may be edited in the Code Editor program, available from the Tools menu.

**NOTE:**

If you select the category Black or African American, this is the signal to the PLUS program that certain prediction equations are to be race corrected (see below). This feature is in keeping with the Federal Cotton Dust Standard, which states that certain prediction equations for persons of the black race are to be reduced by 15% in order to adjust for ethnic differences. This correction factor may also be edited in the *Code Editor*.

If race correction is indicated in the Patient Information program, PLUS software race corrects the following parameters: FVC, FEV 0.5, FEV1, FEV3, SVC, IC, ERV, FRC, TLC, RV, RV/TLC, % FIVC, FIV 0.5, FIV1, FIV3

If you have selected the predicted protocol NHANES3 AFRICAN-AM in *Configuration*, predicted values will already be race-corrected. However, you may still wish to indicate the Race as *Black* in the *Patient Information* dialog. In such as case, to avoid race-correcting twice, access the *Code Editor*, described in Section Three. Select the *Race/Ethnicity* option. Leave the *Black* category as one of the options, but remove 0.15 from the *Race Correction Factor* column.

5. The remainder of the questions are optional and may be used as labeled or for specific information which you define. Any alphanumeric characters may be used.

6. Click on the Optional tab. The following questions will be asked:

**Other Number:** Enter in another ID number if you wish.

**Address 1, Address 2:** On these two lines, enter the street name and any other pertinent information, such as apartment number or unit.

**City:** Enter the city name.

**State:** Enter the name of the state or province.

**Zip:** Enter the zip code (postal code).

**Testing Location:** Enter the Testing Location, for example Outpatient or Inpatient.

**Other Location:** Enter any other information that may be pertinent.

**Room Number:** Enter the room number, for example, if this is an inpatient setting.

**Physician Name:** Enter the physician name.

**Diagnosis:** For this line, you may type in the diagnosis, if any, or select from a pop-up list of available diagnoses that you have previously created in the Code Editor (see Section Three). To get the pop-up list, click on the button next to the Diagnosis line. You may enter more than one diagnosis from the list into the Diagnosis field.

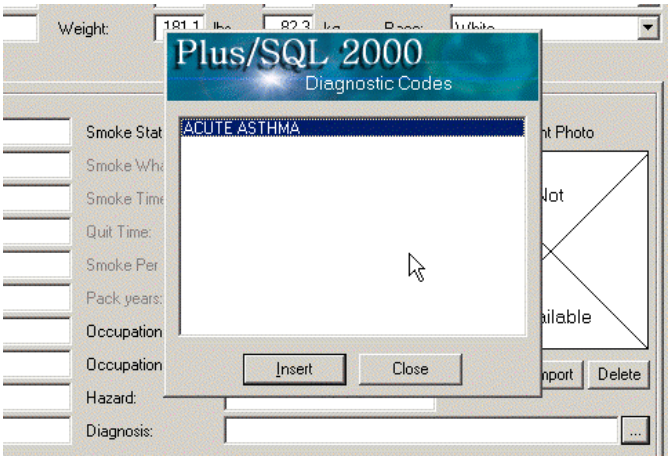



Figure 2-1. Selecting a Diagnosis

**Smoking Status:** The answers for this line are set and are displayed by Clicking on the down arrow.

Click on the desired answer:

*blank (for example, if this information is not available)*
*Never*

*Never - Lives with smoker*
*Quit*
*Quit - Lives with smoker*
*Smokes*
*Smokes - Lives with smoker*

If the answer selected for SMOKING STATUS was NEVER or NEVER LIVES WITH/SMOKER, all subsequent questions pertaining to smoking will be inapplicable and thus will be grayed-out.

**Smoke What:** Click on the down arrow for the following list:

*Cigarettes*
*Marijuana*
*Cocaine*
*Cigars*
*Pipe*

**Smoke Time:** Enter the number of years or months the patient has smoked, in whole numbers (e.g., 5). Press Tab, then click on the down arrow next to Years and select years or months, as appropriate.

**Quit Time:** Enter the number of years or months since the patient quit smoking, in whole numbers. Click on years or months, as appropriate.

**Smokes per Day:** This refers to the number of cigarettes, cigars or pipes the patient smokes per day. Enter the number of units (e.g. 5 cigarettes) or packs (e.g. 2 packs) smoked daily, in whole numbers or decimals. Then click on units or packs, as appropriate.

**Pack Years:** If you selected PACKS, the program will calculate the number of packs multiplied by the number of years smoked and express this as PACK YEARS. For example, if a person smoked 2 packs of cigarettes daily for 5 years, his pack years value would be 10.

**Occupation:** Enter the patient's occupation. When entering the number of months or years the patient has worked at his or her occupation, enter a whole number. Then press the down arrow button and select Months or Years, as appropriate.

**Hazard:** Enter the occupational hazard, if any.

**Technician:** Enter the technician name.

**Patient Photo:** You may insert a picture of the patient by either capturing a screen image or by importing an image file with an extension such as .jpg

To capture an image, click on Capture and follow the ensuing directions.

To import an image file, click on Import at the bottom of the photo place-saver. The program will allow you to browse the files in your system. Click on the desired file and select Open. The selected photo will be inserted into the place-holder.

To export a picture to a file, click on Export, then name the file and place it in the desired file location.

To delete the photo from the patient study, simply click on Delete.

When you have filled in the required fields (Patient ID through Patient Photo) and any optional fields and wish to save the data, click on Save. This patient will be listed as the current patient in the Patient Cache at the top of the screen, meaning that he/she is the current patient.

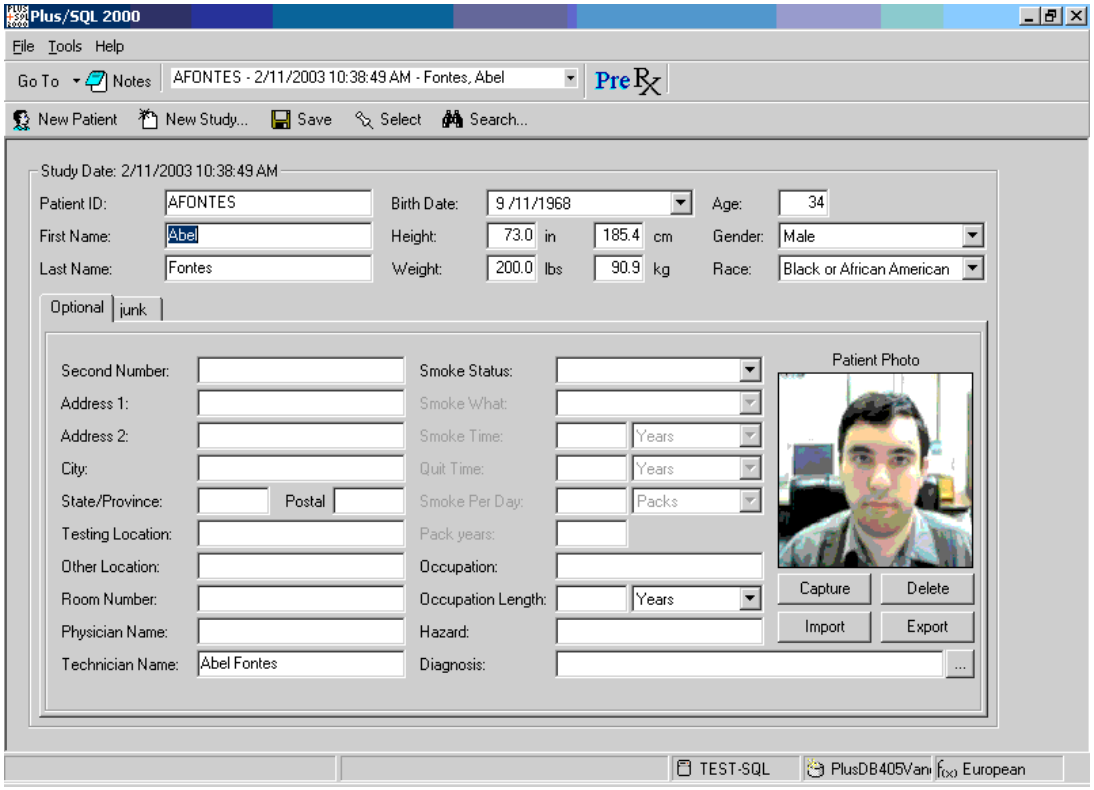



Figure 2-2. Sample Patient Information Screen

**Entering Customized Tabs and Fields**

1. In addition to the Optional tab, you may create custom index tabs with your own information fields. To do so, click on *Tools*, then *Edit Custom Fields*. The User Defined Fields Editor will display.

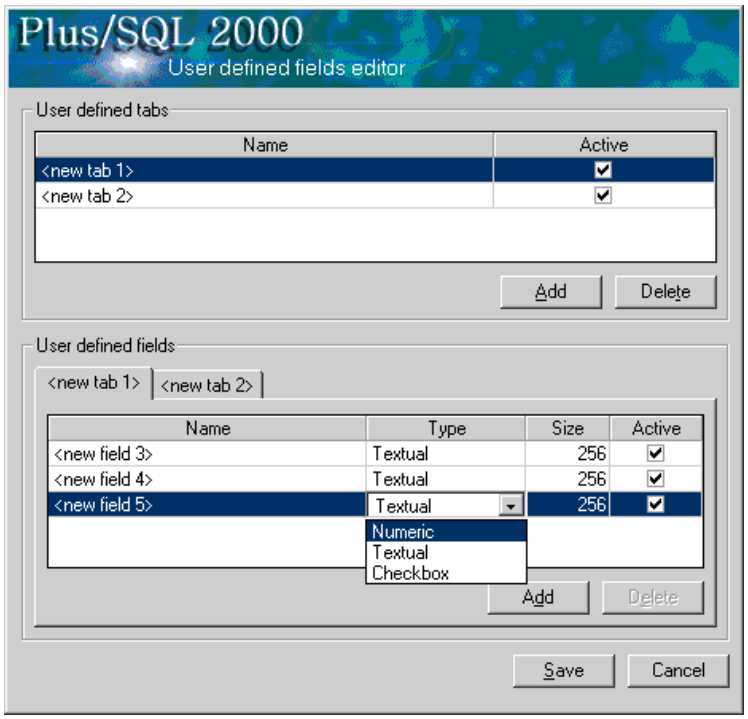



Figure 2-3. The User-Defined Tabs and Fields Dialog

2. In the top panel, click the *Add* button for as many additional tabs that you want to add. Double click on the name to change it from the default to the one you want, for example, from <new tab 1> to *Questionnaire*. Across from each Tab, under *Active*, click on the box if you want the Tab to be active or inactive. If you make it inactive, the Tab will not appear on the Patient Information screen, but will still be available in the User Defined Fields Editor for future use.

3. Each new tab will display in the lower pane. Click on a tab to make it current. Then click *Add* for as many new data fields as you wish to add to this tab.

4. For each field, double click on the name to change it from the default to the one you want, for example, from <new field 4> to *History of heart disease?*. Under *Type*, click the down arrow to display the choices for the type of data field: *Numeric*, *Textual*, or *Checkbox*.

5. What you select under *Type* will limit the size of your field, in the next column. For a text data field, you may have up to 256 spaces. For numeric data, the field is set at 8 and for the checkbox it is set at 1.

6. Across from each field, under *Active*, click on the box if you want the field to be active or inactive. If you make it inactive, the field will not appear on the Patient Information screen, but will still be available in the User Defined Fields Editor for future use.

7. If you wish to delete a tab or field, highlight the desired one and click Delete in whichever pane you're working on.

8. To exit not saving changes, click on *Cancel*. To exit saving changes, click on *Save*.

9. You will see the newly created tabs on the Patient Information screen.

## Searching for a Patient

1. Patient test data is saved to the PLUS database. A database is a collection of information organized for rapid search and retrieval. The Search option makes it possible to retrieve selected patient data from the database.

2. The Patient Search option contains a listing of all patients with studies stored in the database, their respective ID numbers, the date and time of each study performed, and the type of test conducted in each study. You may conduct searches for patients based on their last names, ID numbers, or study date.

3. You may use the Search option as described in the following steps to change the current patient displayed in the patient cache or to select a patient if none displays.

**NOTE:**
If you wish to open a brand new study on a patient, refer *to Creating a Patient Study*.

4. On the Main Screen, click on the Go To, then on Patient Information. Select the Search option.

5. The program will display a screen showing the possible search criteria:

*Patient ID:*
*Last Name:*
*Start Date:*
*End Date:*
*Select All Patients*

6. If you know the Patient ID number, enter it in this box. Then click on the Search button. If the patient exists in the database, his name and ID number will display on the right panel. Click on this line to get the dates and times of each study. Click on the subsequent line to get the test types and modes (Pre/Post) in each study.

7. If you don't know the patient ID, you may enter his last name. Click on Search. The information of patients with this last name will display on the right panel.

8. You may wish to display the information of patients tested between certain dates. In this case, enter the Start Date and/or the End Date for the period you are interested in viewing; then click on Search. Entering just the Start Date will give you the patients tested since and including that date. Entering just the End Date will give you the patients tested before and including that date

9. If you wish to view all the patients in the database, click on *Select All Patients*, then *Search*. The program will display a message that retrieving all patients may take a long time, which would be the case if you have a lot of patients in your database. Click on NO if you do not wish to continue.

10. The Wildcard method allows you to retrieve a group of patients in the index who share a common letter or series of letters in their names. For example, if you wished to view the list of all persons whose last names began with the letters RO, in the Last Name field, you would enter RO. The Patient Index would display all the persons whose last name begins with RO.

11. If there are any notes for the particular study selected, these will display in Technician Notes or Physician Notes box. Refer to the discussion on *Patient Notes* for more details.

12. When you have selected the desired patient(s), their study information will display on the right panel of the Patient Index screen. This information will be set up much in the way that folder and file information is arranged in the Windows® Explorer program. Underneath the name will be the study date and time for each study conducted. A plus sign next to the study date indicates that there is test information to view.

13. Click on the study as you would a folder in order to open it and view its files. The various test types and whether or not they were pre- or post-drug tests will be displayed, along with whether a graph was saved with the test and if it is a priority effort. In order to see the actual test results, highlight the desired test and select View Test from the option line at the top of the screen.

14. In order to make a particular study current, that is the one that you will open and add to or review, highlight that particular study date and time (not just the ID and name), then click on Select. The selected study will display in the patient cache and the program will shift to the patient information screen for that patient.

15. When you proceed to testing operations, you will be testing the last patient and study displayed at the top of the Patient Cache.

## The Patient Cache

1. The *Patient Cache* is a drop-down window that contains a subset, from the full patient database, consisting of the patient studies that are currently being worked with. The patient cache allows these studies to be immediately available without having to search the entire database.

   A patient study is automatically entered into the patient cache when you create, update or select a study in Patient Information.

2. To view the Patient Cache, select *Tools* from the top-level menu, then *Cache Management*. The Workstation cache editor will display with a list of all the studies in the cache.

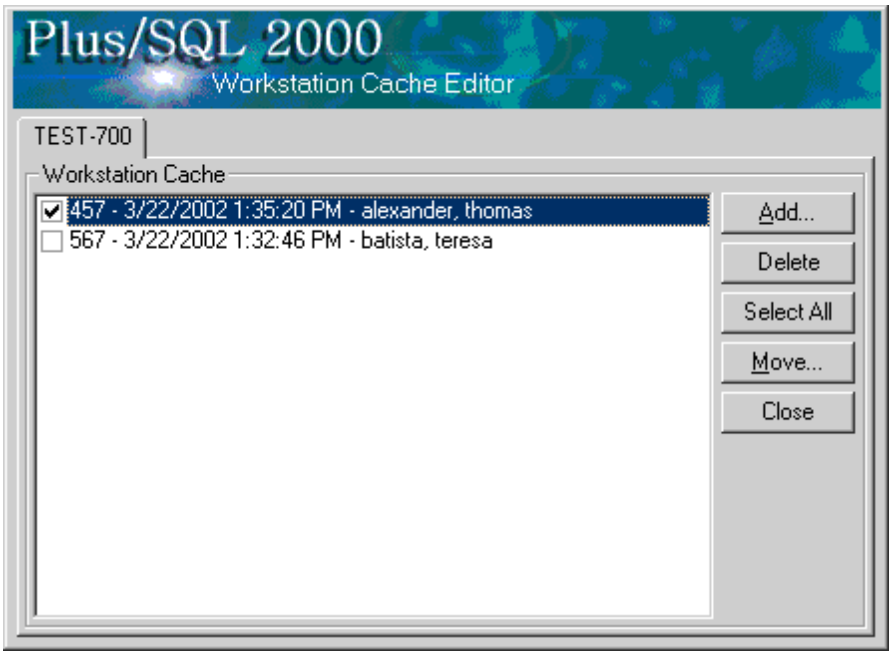



Figure 2-4. The Patient Cache Editor

3. To add to the cache, select *Add*. The program will display the Search screen, where you may select a patient study to add to the cache.

4. If you wish to view the test data of that study before adding it, double-click on the study and the test types will display. Highlight the desired test and click on *View Test*.

5. To add the study to the cache, highlight the study and click on *Add to Cache*.

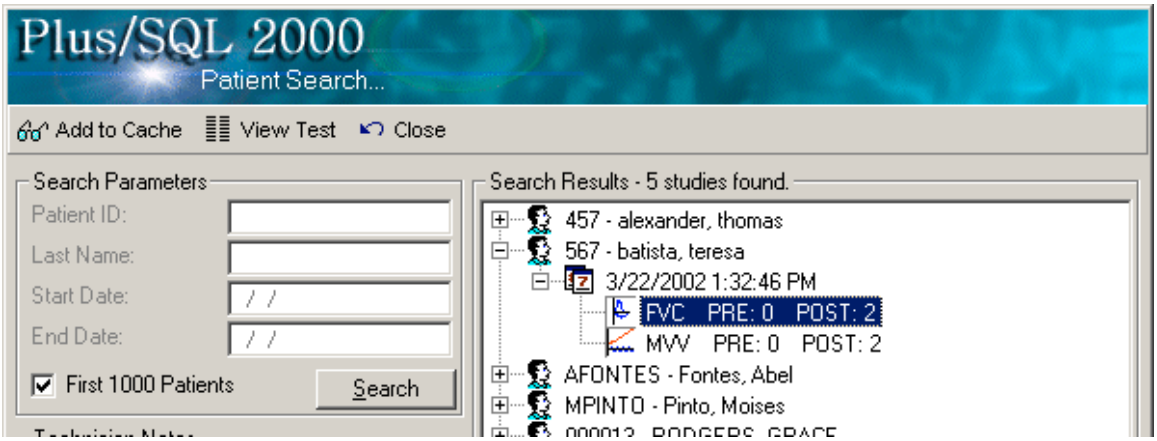



Figure 2-5. Patient Search Screen

6. To delete a study from the cache, click on the box next to it and then select *Delete*. The delete will remove the study from just the patient cache, but not from the database.

7. To select all the studies in the cache for a particular purpose, such as moving to another workstation cache, click on *Select All*.

8. To move the selected study or studies, click on *Move*. The program will ask you to select a workstation to move the study to. Do so and click on *OK*. The studies will be removed from the original cache and transferred to the target cache.

## Creating a New Study on a Previously Tested Patient

1. In order to create a new study on a previously tested patient, enter the desired patient ID and press Tab.

2. Select *New Study* from the Patient Information option line.

3. Enter the *Study Date* as requested.

4. Update the patient information if you wish.

5. Click on *Save* from the option line.

*You may also create a new study for a patient while in the Search option:*

1. On the right panel of the *Search* dialog, highlight the desired patient ID line.

2. Select *New Study* from the top line of the *Search* dialog.

3. Enter the *Study Date* as requested. The program will go to the *Patient Information* screen for the selected patient.

4. Update the patient information if desired.

5. Select *Save* from the *Patient Information* option line.

## Modifying an Existing Study

1. Modifying an existing study refers to changing the Patient Information in a particular study that has already been opened and saved. For example, you may have been testing a patient and found out some new information about him that you would like to go back and add or change.

2. In order to do so, either select the desired patient study from the Patient Cache or search and select it in the Search option. This will bring you to the Patient Information screen for that particular study. Make and save changes according to the directions in Creating a Patient Study, Then select the Save option. The program will save the changes without creating a new study.

3. If you modify the patient age, height, weight or sex after conducting tests, the program will rewrite the predicted and % predicted information.

4. Normally it is desirable to keep tests performed in one day together in one study. Therefore, in this case be sure to not select the New option when you merely wish to update the information.

## Changing the Patient ID

To change a patient ID, select Go To, then Database Utilities. Move Study allows you to move studies under one patient ID to the study of another patient ID. To simply change the patient ID, you would create a blank study with the new patient ID to move the files to.

## Notes Editor

1. The Notes Editor allows you to enter notes for a desired patient study. These notes may then be displayed on the Final Report.

2. The desired patient study must be current. Select the study from the Patient Cache. Then click on Notes.

3. The Notes Editor appears as shown below, with previously entered notes, if any, for the current patient study.

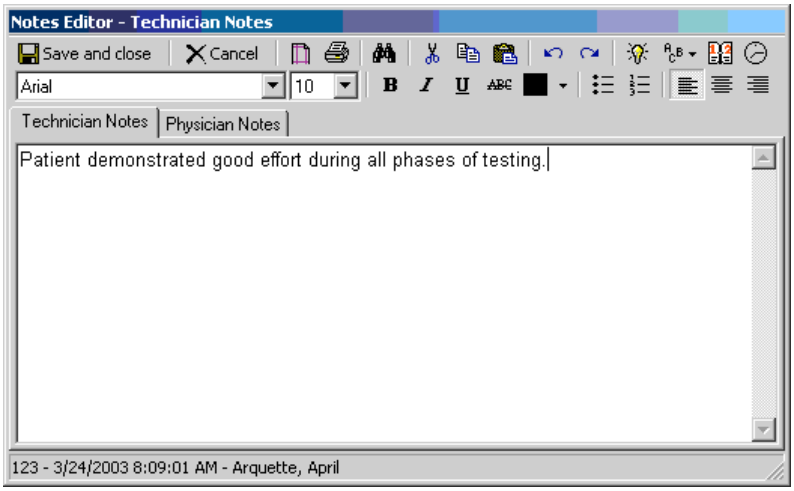



Figure 2-6. The Notes Editor

2. To enter or display Technician or Physician notes, click on the appropriate tab.

3. Following are definitions of certain icons found in the Notes Editor:

- *Page Setup*. Allows you to set up the page for notes. This Page Setup option applies only to Notes printed from the Notes Dialog, not to Notes added to the Final Report.

- *Print Notes*. Allows you to print Notes.

- *Find*. Allows you to locate specified text in the current Notes.

- *Cut, Copy and Paste*. Allows standard cut, copy and paste functions within Notes.

- *Undo, Redo*. Allows you to undo multiple functions that have not yet been saved. Allows you to redo the multiple functions that have been undone and not saved.

- *Insert computerized Interpretation Output*. Allows you to insert the text from the computerized interpretation on the current patient into the Notes file. Simply place the cursor at the desired place and click on this Button to insert the Interpretation.

- *Auto-Text*. Allows you to insert user-created automatic text into the Notes. This saves the time it would take to retype frequently used text. Details are described below.

- These buttons allow you to insert the current Date and Time. Simply insert the cursor at the desired location on the page and click either one of these icons.

- These buttons allow you to conduct standard text formatting functions.

3. When finished entering notes, click on *Save and close*. If you wish to not save the notes, simply click on cancel.

4. In order to view the notes of a selected patient study at any time simply, click on *Notes* and the Notes for that patient study will pop up.

**Inserting Auto Text in the Notes Editor**

1. The Auto Text feature allows you to insert previously created strings of text into the Notes at the cursor position. This can save time by allowing you to insert frequently used text with a Function key or a couple of mouse clicks instead of repeatedly typing the same text.

2. To enter Auto Text, place the cursor at the desired location in the Notes. Click on the AutoText icon. A drop down menu will display the auto text Category.

3. Click on the desired Auto Text category, for example, Diffusion. The String Name menu will display.

4. From the Diffusion category, select the desired string name, for example, Maximal Inspiration. The complete text for the string labeled Maximal Inspiration will display at the insertion point in the Notes. In our example, the text is *Patient did not attain maximal inspiration.*

**NOTE: F2 – F9 Keys**

Alternately, if an F key (F2-F9) was assigned to this particular auto text string, you could simply press this key at the insertion point and the text would be inserted. Auto Text strings can be assigned F2 through F9. After F9, strings have to be selected through the Auto Text drop-down menu. Refer to *Creating an Auto Text File*, below.

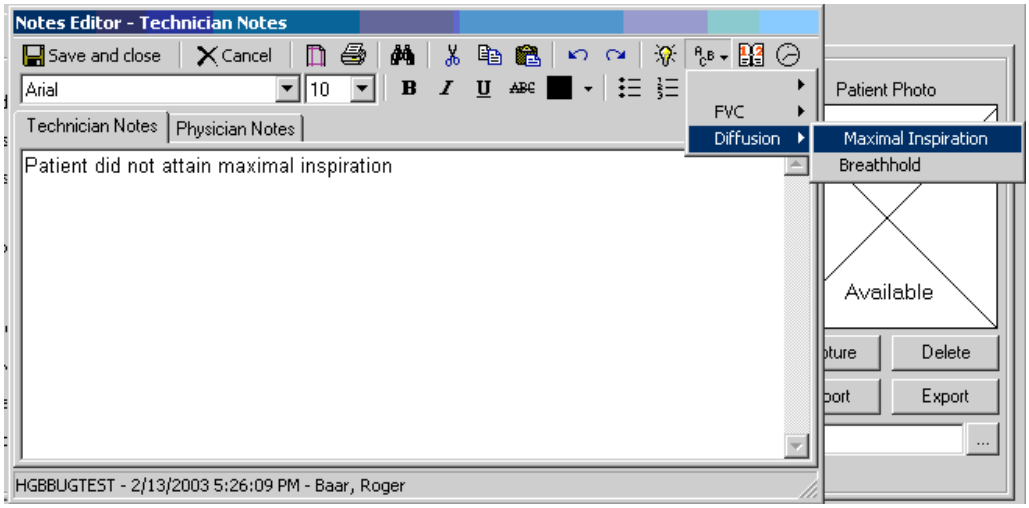



Figure 2-7. Inserting Auto Text in the Notes Editor

5. In order for there to be Auto Text, an Auto Text file must be created, as described below. Then, under *General Configuration*, you must select the desired Auto Text file to make it current.

**Creating an Auto Text File**

1. In order to create an Auto Text file, you must first exit the PLUS program. Auto Text cannot be created or edited while the PLUS program is open.

2. Beginning with the Start menu, access the *Auto Text Editor* from the series of menus shown below.

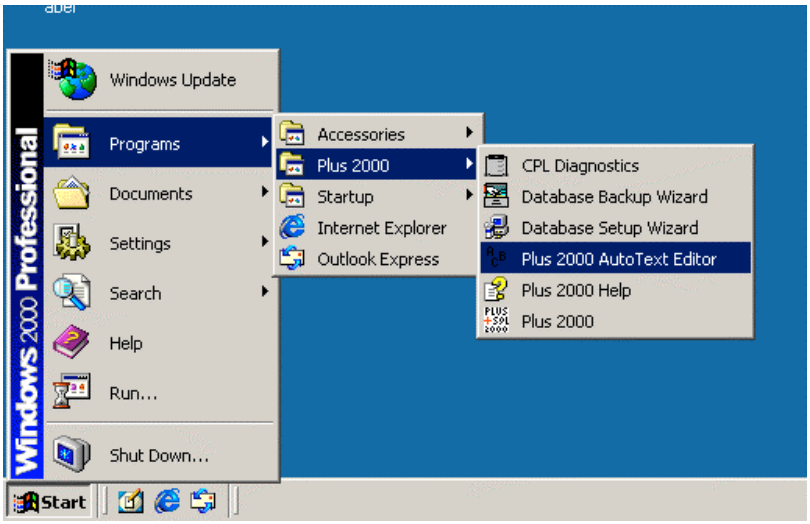



Figure 2-8. Selecting the Auto Text Editor

3. The opening screen of the Auto Text Editor will display.

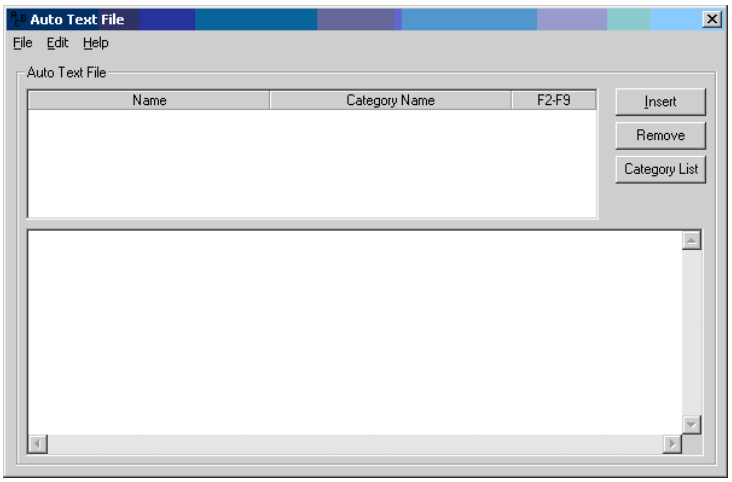



Figure 2-9. Auto Text Editor Opening Screen

4. To create a line of Auto Text, click on *Insert*. You must assign the line a name, and optionally, a category and a Function key.

5. Let's say you want to create the line *Patient exhibited good effort* for the FVC test. You could call this line *Good Effort*. Type *Good Effort* in the Name column.

6. If you wanted to assign *Good Effort* to the category FVC, you would first have to create a category list with FVC in it. To do so, click on the Category List button. The Category List dialog will display.

7. Insert lines in the Category List dialog and name them. In our example, we have used test types for the categories.

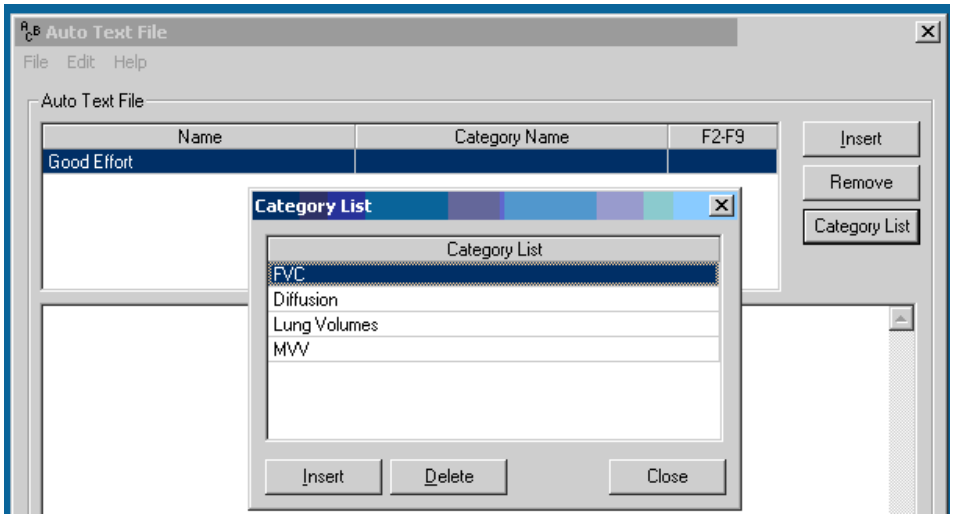



Figure 2-10. Creating Categories in the Category List Dialog

8. Close the Category List dialog. Click on Category Name to get the drop down menu of the categories just created. Select FVC from this list.

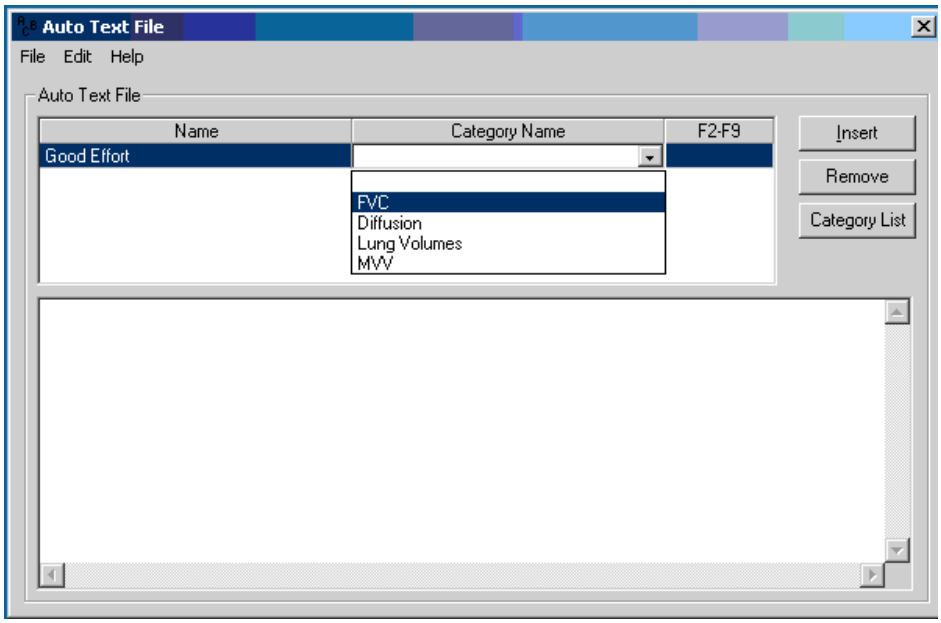



Figure 2-11. Selecting from the Category List

9. In the third column, you may assign this text line a Function key from F2 through F9 for convenient insertion in Notes.

10. To assign text to the desired line, select the line and type the associated text in lower pane of the Auto Text dialog. Continuing with our example, we would select the *Good Effort* line and type *Patient exhibited good effort* in the lower pane.

11. Shown below is an example of what additional lines in the sample Auto Text file might look like.

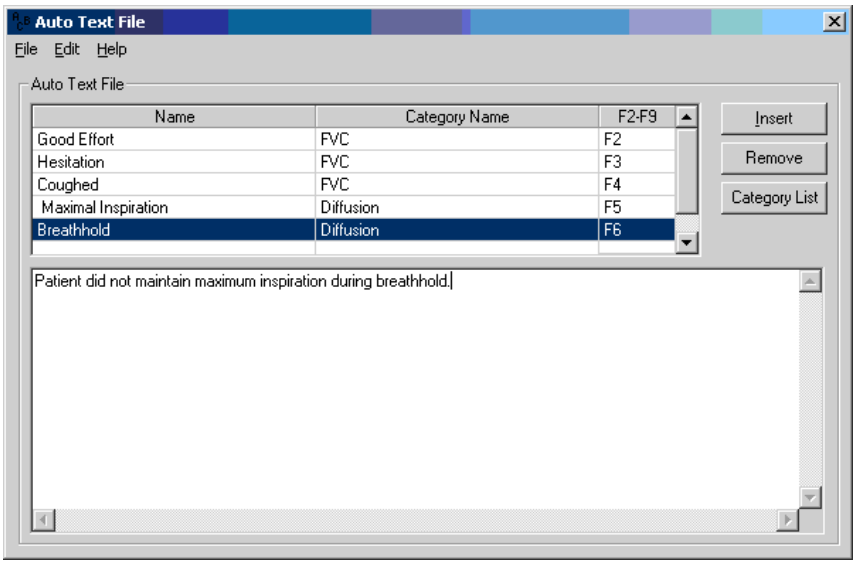



Figure 2-12. Adding Lines to the Auto Text File

12. When you have finished configuring the Auto Text file, select File and Exit. The program will ask if you wish to save the file. Answer Yes. Name the file, placing it in the desired folder. Auto Text files have the extension .atf.

13. In order to make this Auto Text file current, go into General Configuration. At the line Auto Text File, click on the button to search for the desired Auto Text file; double click on the desired file name to enter it in this line.

14. If you wish to edit an Auto Text file, you must close the PLUS Program and go into the Auto Text Editor again. Click on File and browse for the desired Auto Text File. Double-click on the file to display it in the Editor and make any desired changes.

## Closing and Opening a Study

1. An administrator has the ability to close a study and lock it so that it may not be accessed again, except by an administrator. The information entered in either the *Close Study* or *Open Study* option will be recorded in the patient's *Study Status*, which is described following this topic.

2. The *Close Study* option is available from the File menu and applies to the currently opened study. To close the current study, select *Close Study*.

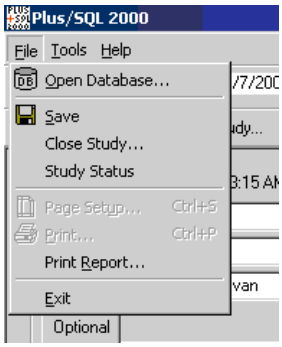



Figure 2-6. The Close Study Option on the File Menu

3. The *Close Study* dialog will display, as shown below.

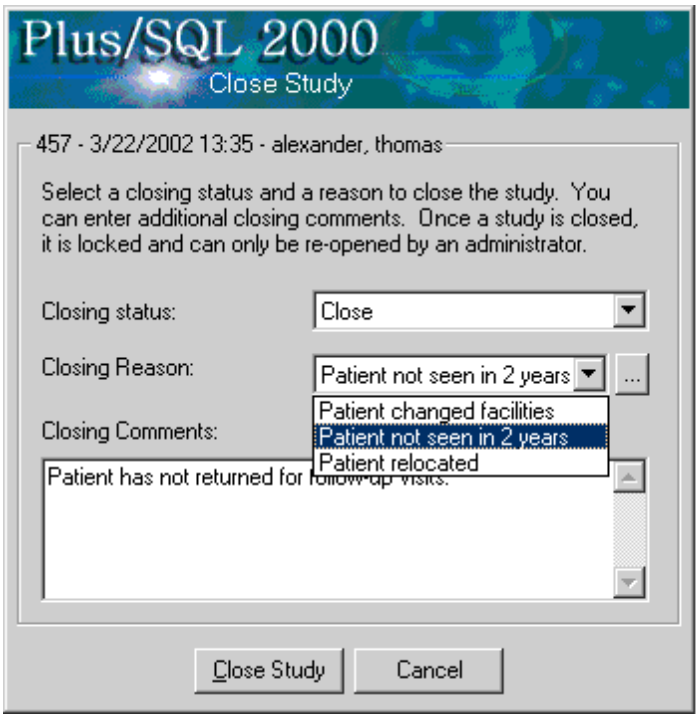

Plus/SQL 2000
Close Study
457 - 3/22/2002 13:35 - alexander, thomas
Select a closing status and a reason to close the study. You can enter additional closing comments. Once a study is closed, it is locked and can only be re-opened by an administrator.
Closing status:
Close
Closing Reason:
Patient not seen in 2 years
Patient changed facilities
Patient not seen in 2 years
Patient relocated
Closing Comments:
Patient has not returned for follow-up visits.
Close Study
Cancel

Figure 2-7. The Close Study Dialog

4. The program will present drop-down lists from which you must select a *Closing Status*, such as *Transmitted*, and a Closing Reason. The *Closing Reason* list is created by an Administrator in the *Code Editor*, which is described in the *Section Three -- Configuration*.

5. To access the *Code Editor* in order to add to or delete reasons from the *Closing Study Reasons* list, click on the dotted line button next to the *Closing Reason*. The *Code Editor* for just the *Closing Study Reasons* will display. Refer to *Code Editor* for more details.

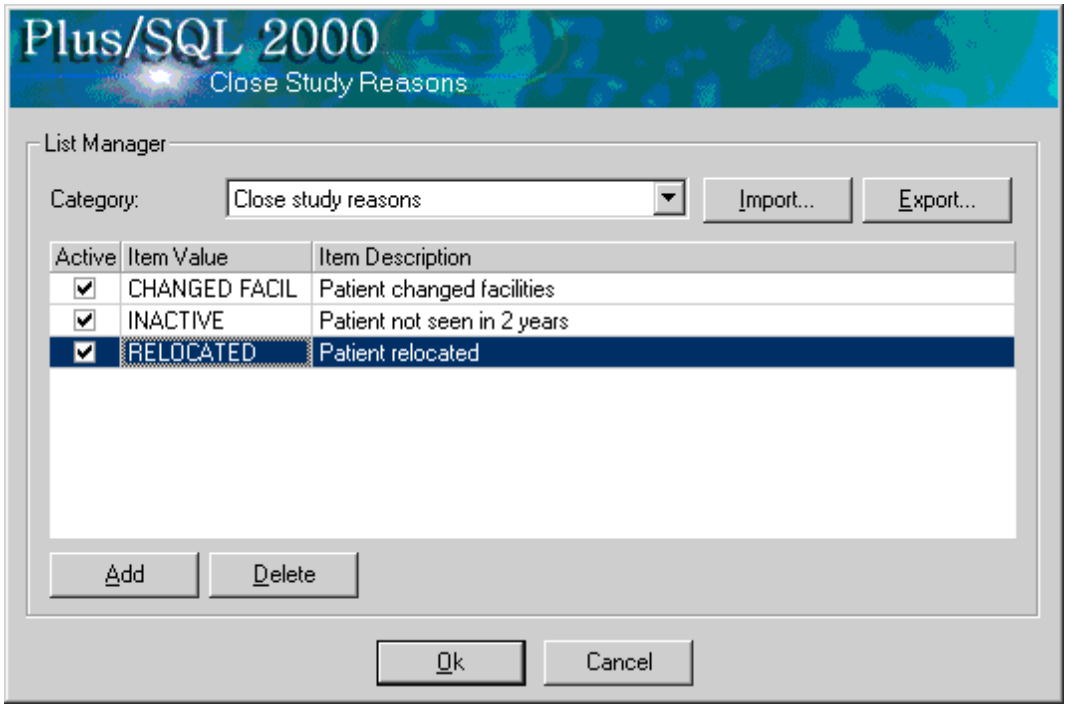



Figure 2-8. Close Study Reasons Dialog

6. When you've returned to the initial *Closing Study* dialog, double-click on a *Closing Reason*, such as *Patient Relocated*, to select it.

7. In the *Closing Comments* box you may add additional information pertaining to the patient's closing status.

8. When finished entering information, click on the *Close Study* button to finalize the closure. The program will warn you that the study will be locked and may be reopened only by an administrator. Click on OK. The study information for that patient on the Patient Information screen will be grayed-out.

9. To open a study that has been closed, select the desired study to make it current. Then from the File menu, click on *Open Study*.

10. The program will display the *Open Study* dialog.

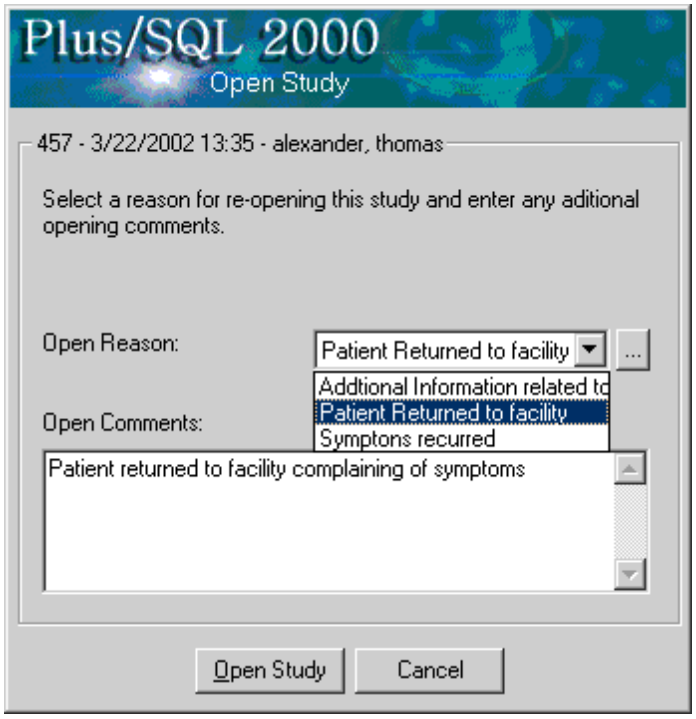



Figure 2-9. The Open Study Dialog

11. The program presents a drop-down list from which to select a reason for opening the study. Like the *Close Study* reason list, the *Open Study* reason list is created by an Administrator in the *Code Editor*, described in *Section Three -- Configuration*.

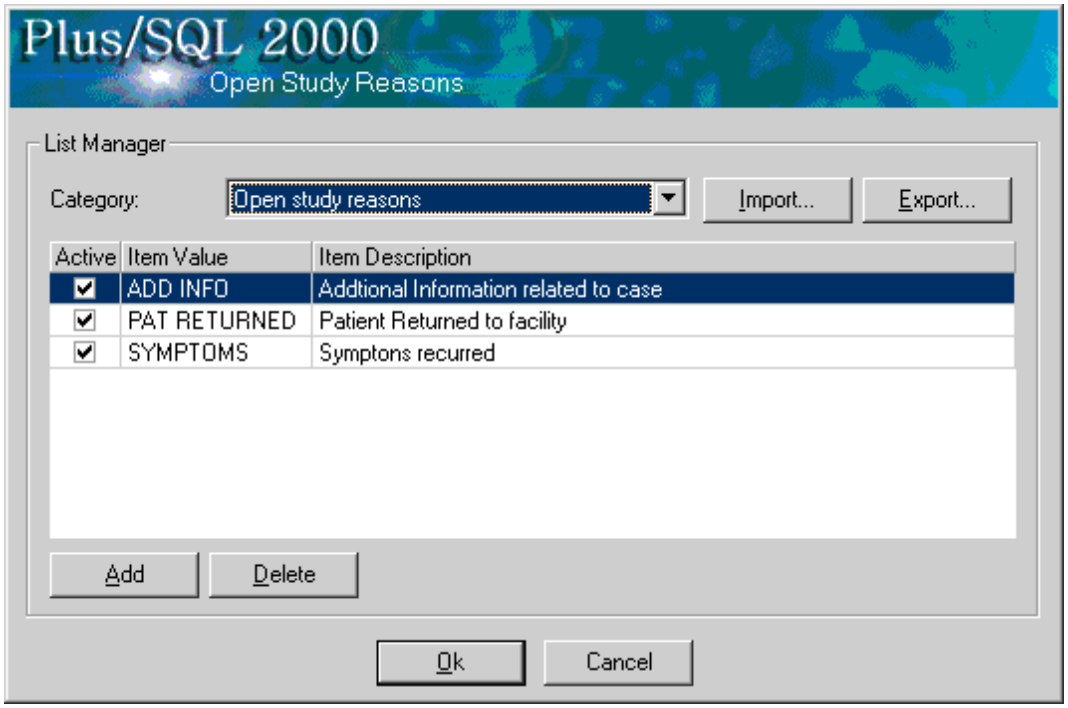



Figure 2-10. The Open Study Reasons Dialog

12. To add or delete *Open Reasons* from the drop-down list, click on the dotted-line button and proceed with editing the list as described above for the *Closing Study Reasons* list.

13. Back at the initial *Open Study* dialog, select a reason to open the study. Then click on Open Study to finalize the procedure. Back at the Patient Information Screen, you will notice that the patient information is not grayed-out.

### Study Status

1. To view the history of the patient's study status, click on Study Status from the File menu. The program will display the Study History log, which indicates when tests for that study were saved, when studies were opened, when they were closed (loaded), etc. Refer to the preceding topic for a discussion of Opening and Closing studies.

2. When you click on a particular line, the program will display in the Comments box any comments that may have been entered at the closing or opening of the study. An asterisk (*) in the Action column for a particular line indicates the current status of the study.

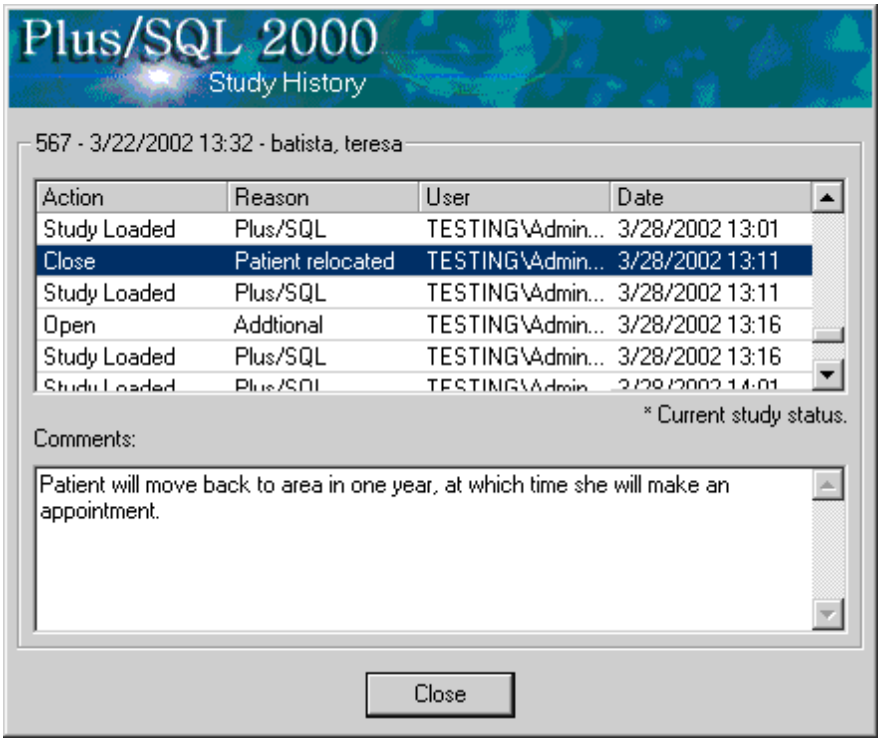



Figure 2-11. Sample Study Status Screen

3. When finished viewing the study status, click on *Close* to return to the File menu.

### Prediction Equations

1. Predicted results are expected test results derived from a study population sharing the same age, sex, height, weight, and racial characteristics as the current patient. Prediction equations allow you to compare the current patient's values to the values that healthy persons of these given characteristics attained.

2. PLUS/2000 provides several sets of prediction equations with which to compare your patients' results. Refer to *Section Three -- General Configuration*. The software automatically calculates predicted and percent of predicted results based on what you enter in Patient Information and the currently selected prediction equation set. *Percent of Predicted* tells what percentage of the predicted value that patient obtained in testing. The PLUS program shows Percent of Predicted results in tabular data screens.

3. Refer to *Section Eight - Plus/SQL 2000 Predicted Editor* for a description of how to customize existing predicted equations or enter new ones.

### Confidence Intervals

1. The *95% Confidence Interval* is a value, which when subtracted from or added to the predicted value, will give the lower or upper limit of normal. Certain predicted equations selectable in the PLUS program, such as the CRAPO_CI set, contain confidence intervals.

2. The term *95% Confidence Interval* indicates a likelihood of 95% that values within these limits are normal. In the PLUS program, if a predicted equation has a mean value along with a lower and/or upper limit, the system will base all % predicteds values on the mean and still print the lower, upper, or range in the predicted column.

## Database Utilities

1. Database utilities provided in the PLUS program help the user efficiently manage data that is generated during patient testing. For example, to maximize the speed and efficiency of the working database, you may wish to store all but the current week's studies in an archival database. This is possible using the database utilities.

2. Click on Go To, then on Database Utilities. The program will display four option tabs. Each is defined below.

   **Export Study** allows you to move selected files from the source database to the target database. Use this option to move files from the PLUS database to an archival database.
   **Import Study** allows you to move files from one PLUS/2000 database to another PLUS/2000 database. For example, if you had previously moved some studies from the PLUS database into an archival database and wished to move these studies back into the PLUS database, you could use the Import Studies option.
   **Move Study** allows you to move studies under one patient ID to the study of another patient ID. You could use this option to effectively change the original patient ID.
   **Predicteds** allows you to import predicteds from a file or export them to a file for the purpose of transferring them to different databases.

3. Click on the Export Study tab. There are two options within Export Study. *Export* means to move copies of the files from the source database and send them to the target database while still keeping the originals in the source database. *Extract* means to actually remove the files from the source database and send them to the target database without leaving behind the originals.

4. You will see two data panes, the left one labeled Search Results, the right one labeled Studies to Export. In the left pane, you will search for potential studies to export. You will use the right pane to finalize the export process.

5. Click on the Search button below the Search Results pane. A dialog will display providing the various methods for conducting study searches: by Patient ID, Patient Last Name, Starting Date, Ending Date, the first 1000 patients in the database, or the patient studies currently in the patient cache for that workstation. This is similar to the dialog found in Patient Information. Select the desired method and click on the Search button in the dialog. The designated studies will display in the Search Results pane.

6. When the desired patients display in the Search Results pane, you must first move the studies you wish to export or extract into the Studies to Export pane on the right. You may move all studies displayed on the left to the Export pane by clicking on the double arrow button facing the Export pane. Or you may select the desired study in the left pane and move it over to the Export pane by clicking on the single arrow facing the Export pane.

7. Select the studies you wish to export or extract. If you make a mistake and wish to move a study or studies back to the Search Results pane, simply highlight the studies and click on the appropriate left-pointing arrow.

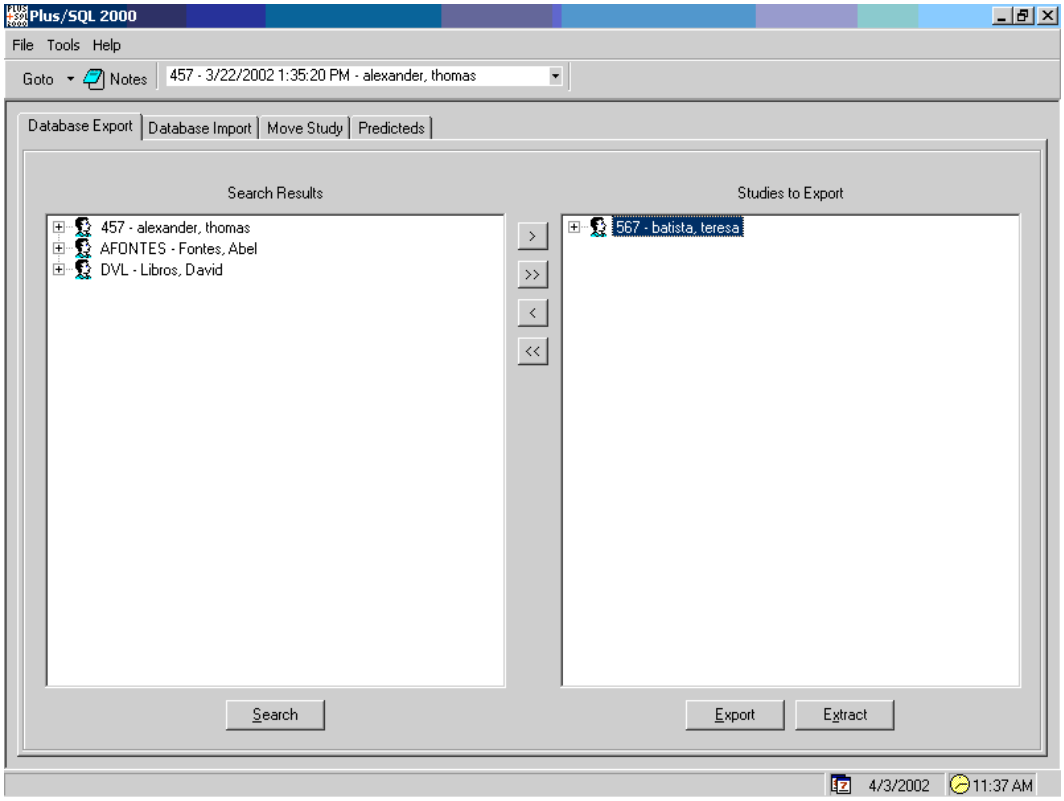



Figure 2-12. The Export Study Dialog

8. When you have moved the desired studies into the Studies to Export pane, click on either Export or Extract, depending on which option you choose. The program will display the Export File To screen. Enter the name of the drive, folder and file to which you wish to Export or Extract the studies, for example C:\archive\studies 8-1 to 10-31 2000.xml. This could be the name of a file that contains the archived studies from 8/1 - 10/31, 2000. The .xml extension is added automatically.

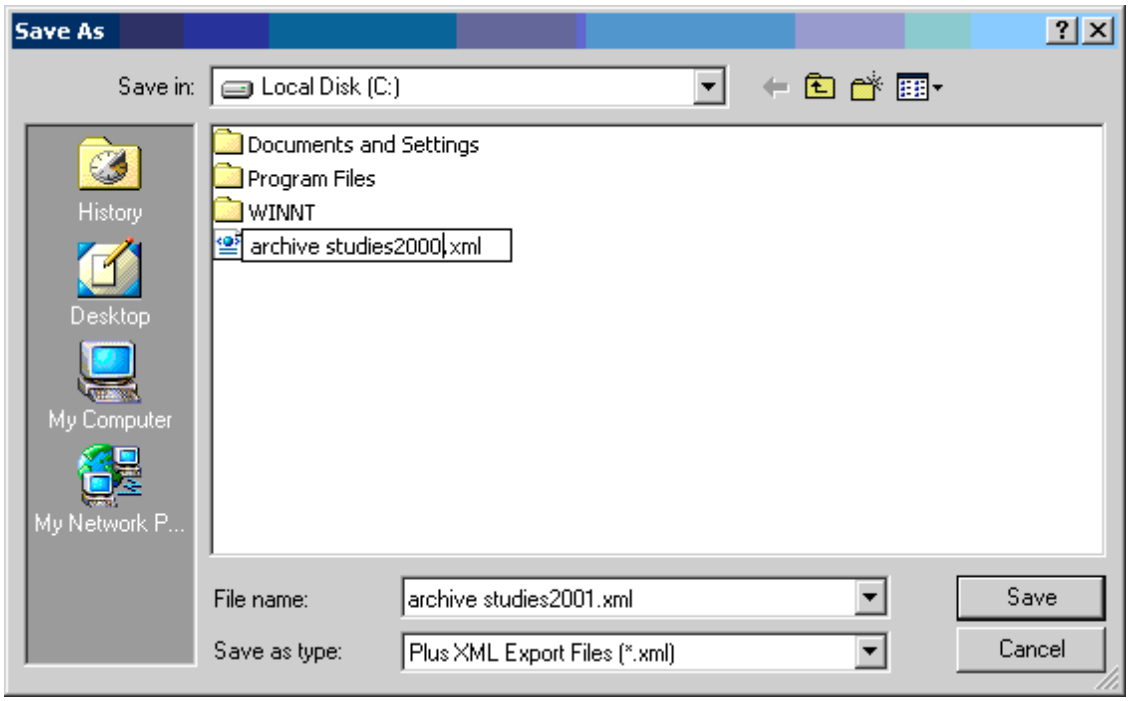



Figure 2-13. Sample Export Study File

9. To import studies from a file, click on the *Import Study* tab. Two panes will display. The one on the left for Loaded XML Studies and the one on the right is for Studies to Import. In the Loaded XML Studies pane you will list the .XML files that contain the studies you wish to import. These may be studies that you had exported to an XML file previously for the purpose of archiving.

10. In the line below the Loaded XML Studies pane, enter the drive, folder and name of the file where you have stored the studies you wish to import, for example, c:\archive\studies 8-1 to 10-31 2000.xml. If you do not remember this information, click on the button next to the line to search for the file.

11. When you have located the desired file, highlight it and click on the Open button. The studies will appear in the Loaded XML Studies pane.

12. Move the desired study(ies) over to the *Studies to Import Bin* by highlighting the study and then clicking on the arrow facing the Import Bin. If you wish to move all the studies over to the Import Bin at once, just click on the double arrow key pointing to the *Studies to Import* Bin.

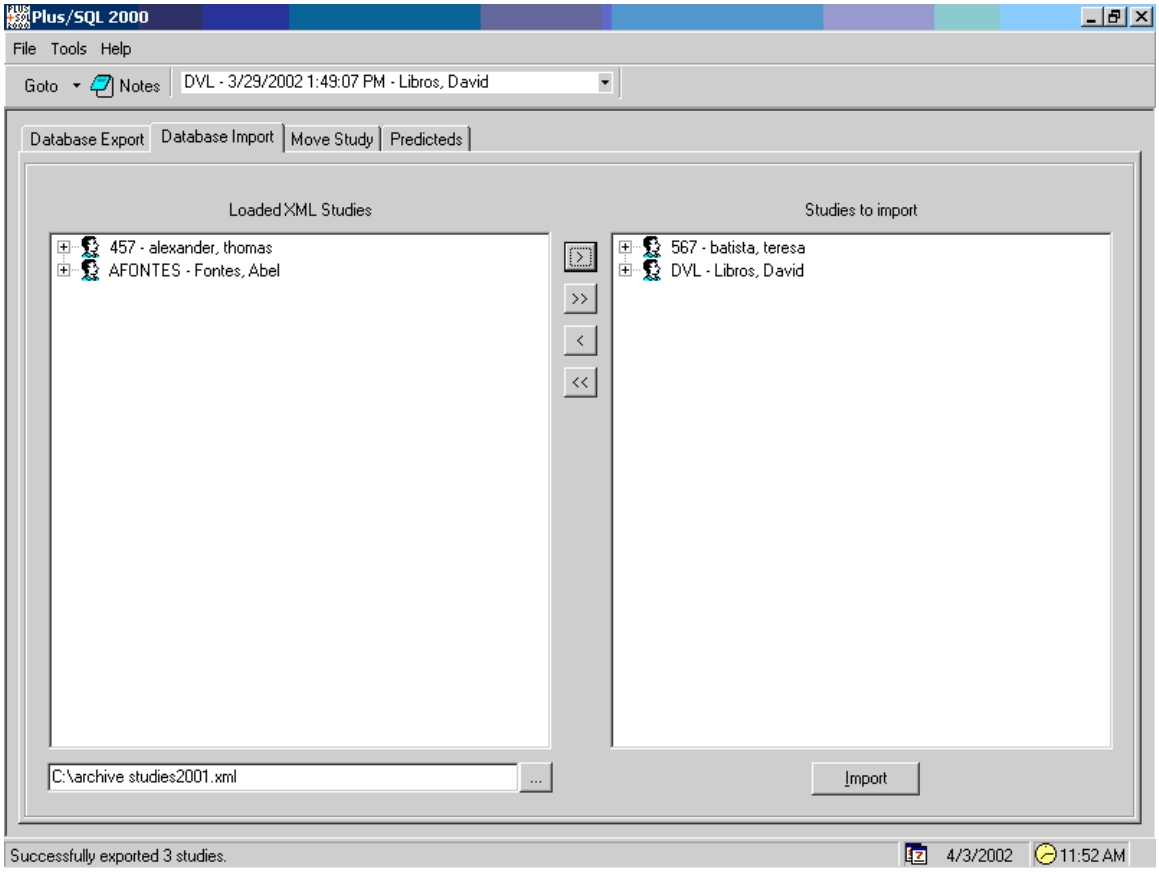



Figure 2-14. The Import Study Dialog

13. When you have moved the desired studies into the Import Bin, click on Import. At the end of the Import procedure, the program will state the following:

*Import completed successfully, a log file was generated.*
*Log File*_____

14. Enter the name of the log file. The imported studies will now be in the source database. If you return to Export Study and conduct a new search, you will be able to see the newly imported study.

15. To move studies from one patient ID to another ID, click on *Move Study*. The program will display two panes. One is labeled Source Study and the other is labeled Destination patient.

**WARNING:**

Use caution when moving studies, as doing so could corrupt data and lead to record loss.

16. Below the Source Study pane, click on Search to find the ID number of the patient whose studies you wish to move, using the same methods described under Export Study.

17. When the desired patient appears in the Source Study pane, double-click on that patient to list his studies.

18. Click on the desired study to highlight it.

19. Conduct a search on the Destination Patient pane to locate the patient ID to which you wish to move the study. Highlight the desired patient ID in the Destination pane by clicking on it.

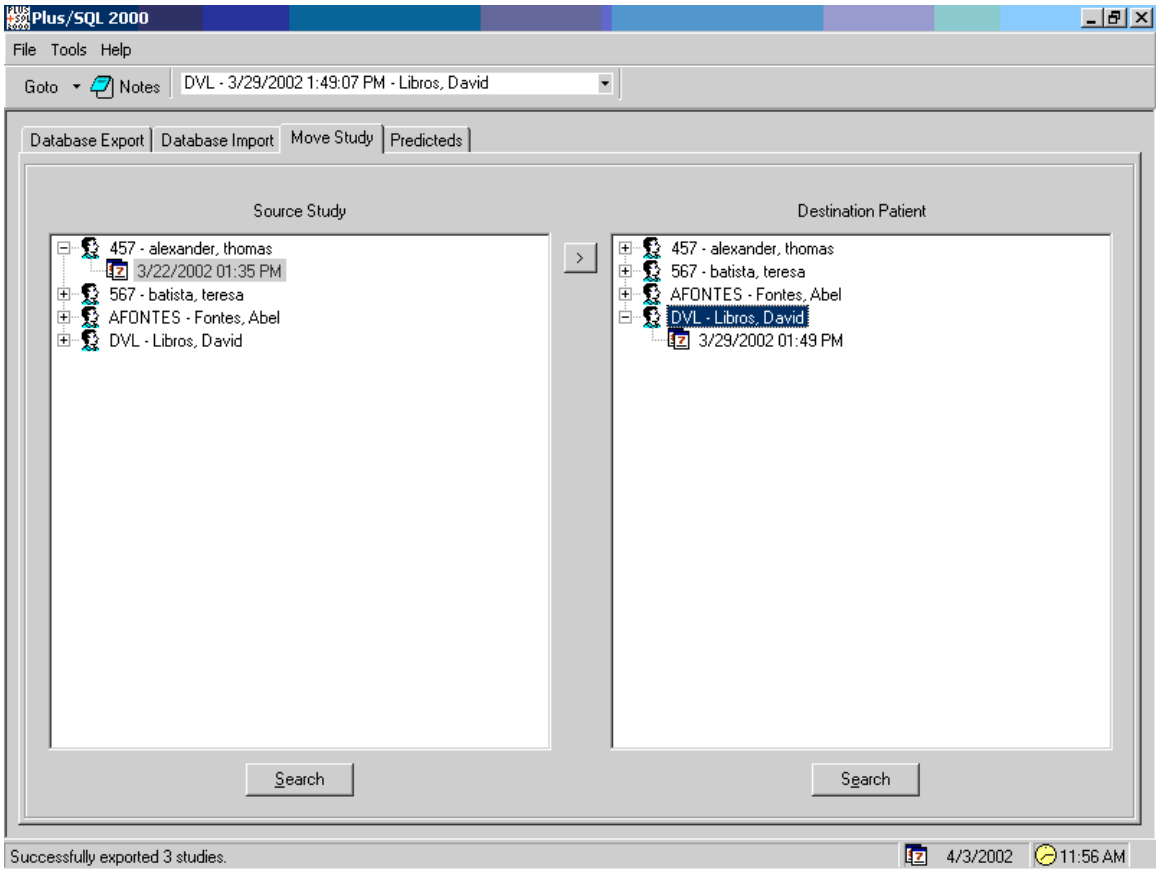



Figure 2-15. The Move Study Dialog

20. Move the highlighted study from the Source Study pane over to the highlighted patient ID in the Destination pane by pressing the right-facing arrow key. An error message will display if no patient ID was highlighted in the Destination pane.

21. The program will ask if you wish to finalize the move (see the NOTE, below). If so, answer Yes. If you decide against moving the study, simply answer No. When you answer yes, a message will display indicating that the move was successful. If you return to Export and conduct a new search, you will see the moved study under the Destination Patient ID. It will be highlighted in red.

22. Repeat for as many studies as you wish to move

**NOTE:**

After answering Yes to *Are you sure you wish to move the study?*, you may not move a study back to the Source Study by simply clicking on the left arrow. You must set up a

new Move screen with the original left panel patient ID as the new Destination patient ID on the right panel in order to do so. Note that a moved study will always be highlighted in red, even if you move it back to its original patient ID.

23. To import or export predicted equations or protocols (sets), click on the Predicteds tab. This feature may be used in conjunction with the Collins Predicted Equation/Protocol Editor and is discussed in Section Nine.

## SECTION THREE - CONFIGURING THE PLUS PROGRAM

### About Configuration

1. The Configuration program allows you to customize aspects of the software to tailor it to your needs. To accept the default configurations in the PLUS program, you may skip this chapter for now and proceed with Testing and Calibration.

   Another purpose of Configuration is to display what testing devices are installed in the system. If you have device with a USB connection, such as the Collins GEM, the software will read this device internally and automatically display the device and serial number on the Product line. The Testing Device line will automatically display the valve or pneumotach used, such as *GEM Pneumotach*.

   **NOTE:**
   The following description serves as a guide to the Configuration program. Depending on the devices present in your system, certain options will vary from the examples used herein.

2. Configuration is available from the Tools menu and is divided between two options:

   - The **Configuration Editor** – describes software configuration
   - **Configure Hardware** – describes configuration for the device(s): GS, CPL, Body Box, Eagle, Eaglet or GEM/Hawk.

   You must configure the hardware before the software.

3. The sections of the Configuration program that are available to you depend on the level of your permissions, which are described in System Security. Administrators, who are users with full permissions, have access to all sections of Configuration. Those with limited permissions, such as Users, will see some lines of the Configuration menu grayed-out, which means these are not available to them.

   **NOTE:**
   Some Hardware Configuration lines may also be grayed out for devices with USB connections to the computer. You do not have to fill in these lines because with USB devices, these lines are filled in automatically.

4. The following Configuration descriptions will assume full Administrative rights. Therefore, if you have non-administrative rights, keep in mind that not all aspects will apply to you.

5. An administrator can make a configuration change for just one user or for all users. This is what is meant by the question at the end of each section, *Persist these changes to all users?*. However, a non-administrative user can only make the changes apply to himself. Therefore, this question will not display for the non-administrative user.

6. For each configuration section, there is a Reset option which will reset whatever changes you have made back to the default settings.

7. In addition to the Configuration options, aspects of the database may also be configured by selecting *Open PLUS Database* from the File menu while at the Patient Information screen.

8. To configure an FVC Challenge program, refer to *FVC Challenge Editor.*

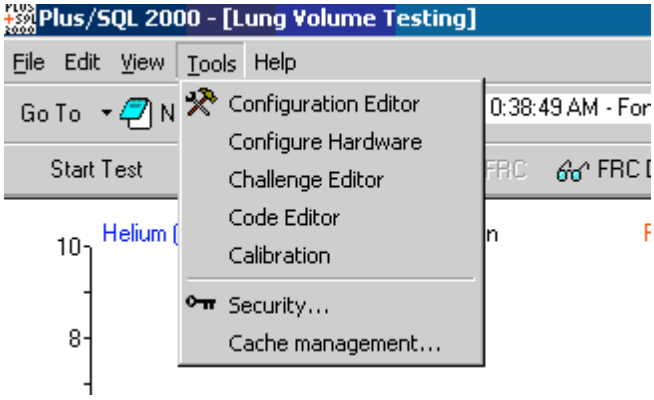



Figure 3-1. The Configuration Options on the Tools Menu

## Hardware Configuration

1. You must configure the system hardware before proceeding to software configuration.

2. Click on *Tools* from the Windows® menu, then on *Configure Hardware*. The Configure Hardware screen will display with tabs for each area of configuration, which are described below.

3. There are currently several systems that can be used with PLUS/2000 software: the *GS*, *CPL*, *Eaglet*, *BP*$^{D}$, *GEM/Hawk*, and *Eagle*. Configuration for each device is described below.

**NOTE:**
For each device, options that do not need to be filled in are grayed-out.

### GS Hardware Configuration

1. The *GS* tab refers to the model previous to the CPL. Click on the first option, *Interface*. Click on the down arrow in the Value box. Enter *None* if you do not have the GS. Enter *ISA* if you do have the GS.

2. Answer each of the remaining questions appropriately if you have this system. The questions are similar to the following option, CPL.

### CPL Hardware Configuration

1. To configure the CPL hardware, click on the *CPL* tab. The configurable categories will display. Most of the answers in this and other sections involve clicking on the Value and then the drop-down arrow to select from a menu. In some cases you have to type in information.

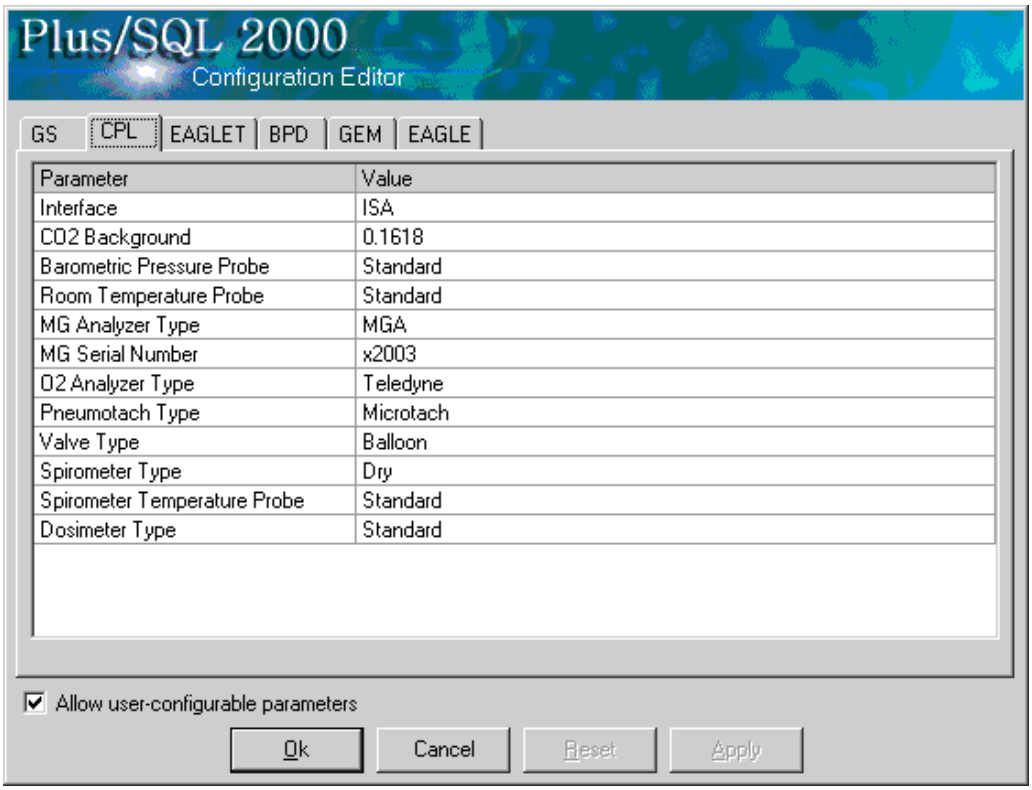



Figure 3-2. The CPL Configuration Tab

**Interface:** *None / ISA /USB*
The options that display for this line depend on what you have for a CPL interface. If you have a CPL with an ISA interface, select ISA. If you have a CPL with a USB connection, *CPL* and the serial number will be automatically displayed on the line. If you have more than one CPL with USB interface connected, the drop-down menu will display these devices along with their respective serial numbers. Select the serial number of the CPL you are conducting tests with.

**$CO_2$ Background:**
This is a number determined for each microGA analyzer at the time of manufacture. It is recorded on a sticker on the analyzer, at the rear of the CPL. If not already entered here, type in the $CO_2$ background value

**Barometric Pressure Probe:** *Standard / None*
The CPL comes equipped with the standard BP probe.

**Room Temperature Probe:** *Standard / None*
If you have the GS or the CPL, you have the Standard probe, which is labeled Room Temp and located on the control panel. This probe determines the temperature corrections used in the software equations.

**MG Analyzer:** *None / 3G / 4G / MGA*
If you have the CPL system, you have the MGA analyzer. If you have the GS, you have either the 3G or 4G multigas analyzer. Answer accordingly.

**MG Serial Number:** Enter the Serial Number of the MG analyzer, located on a sticker at the rear of the CPL.

**O2 Analyzer:** *None / Servomex / Teledyne*
If you have the CPL system, you have the Teledyne O2 analyzer. If you have the GS system, you have the Servomex.

**PneumotachType**: *MicroTach / None*
If you have a pneumotach, it would be the Collins MicroTach. Otherwise, enter None.

**Valve Type:** *None / UBV / Balloon*
This refers to the type of spirometry valve you have. If you have the GS, answer UBV. If you have the CPL, answer Balloon.

**Spirometer Type:** *None / Dry / Wet*
Dry and Wet refer to the Dry-seal or Water-sealed spirometer. Answer accordingly.

**Spirometer Temperature Probe:** *None / Standard*
The Spirometer Temperature Probe, which allows you to monitor the temperature of the spirometer, is optional equipment for both the GS and CPL. It is a small protrusion located on the top of the inside body of the spirometer. If you have this probe, enter Standard.

**Dosimeter Type**: *None / Standard*
If you have the Collins dosimeter, enter Standard.

2. At the bottom of the screen is a checkbox for *Allow User Configurable Parameters*. If you have Administrative privileges, you may check this box to allow users to override some of these parameters during the test. If you do not want to grant this option, leave it unchecked. This option applies more to the software configuration sections, where for example, the user may wish to change the colors of the tracings during the test for better visibility. However, the tracing colors for the final report would remain the Administrative selection.

3. After making changes for this section, if you wish to return to the original settings, click on Reset. When satisfied with the settings, click on Apply to save them and remain in the Configuration Editor. Click on OK if you wish to save them and leave the Configuration editor. Otherwise, click on Cancel to leave this the program and not save the changes.

**NOTE:**
When you have made a change, that particular parameter will be highlighted in a pale yellow to show the intended changes. When you click on Apply, the highlighted parameters will change back to white to show that they have been saved.

**Eaglet Configuration**

1. Select this tab to configure the Collins Eaglet.

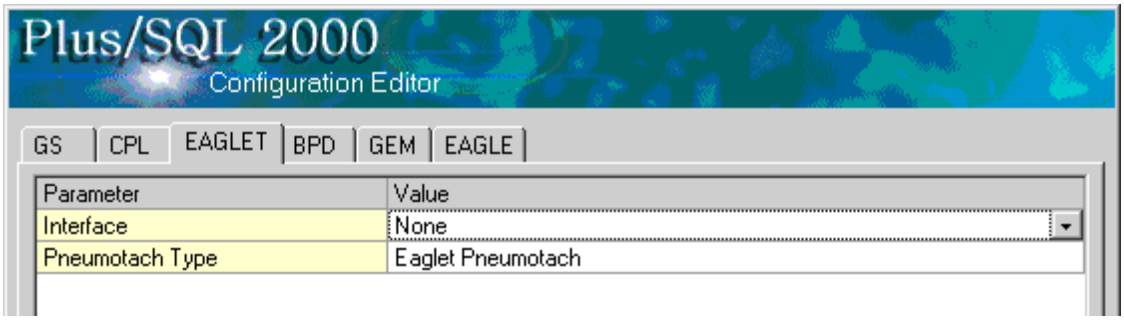



Figure 3-3. Configuration Tab for the Collins Eaglet

3. From the drop-down menus, select the Interface and Pneumotach type.

**Interface**:
If you have the Collins Eaglet, *Eaglet* and the serial number will be automatically displayed on the line. If you have more than one Eaglet connected, the drop-down menu will display these devices along with their respective serial numbers. Select the serial number of the Eaglet you are conducting tests with.

**Pneumotach Type:** *None / MicroTach/ Eaglet Pneumotach*
Enter *Eaglet Pneumotach.*

**BP$^{D}$ Configuration**

1. This tab refers to the hardware aspects of the BP$^{D}$ Body Plethysmograph. If your BPD is equipped with the GEM module, you must also select the GEM tab for configuration.

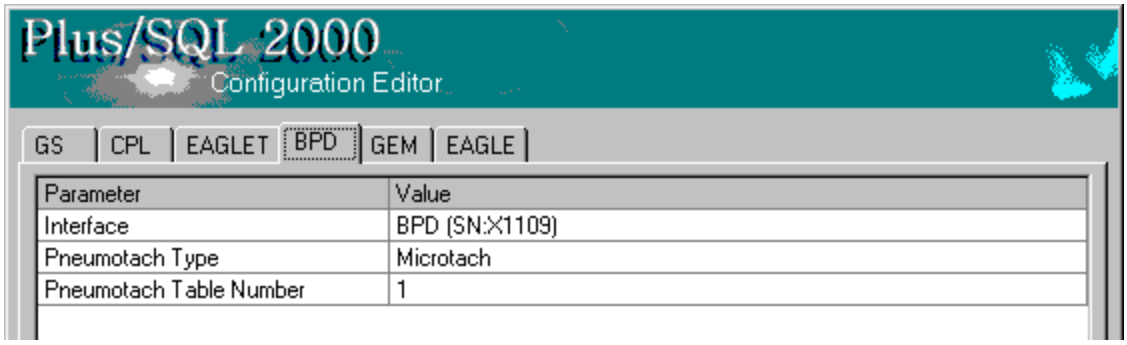



Figure 3-4. Configuration Tab for the Collins BP$^{D}$

2. The questions are as follows:

**Interface**:
If you have the Collins BP$^{D}$, *BP$^{D}$* and the serial number will be automatically displayed on the line, as shown in the figure above. If you have more than one BP$^{D}$ connected, the drop-down menu will each available device along with its respective serial number. Select the serial number of the BP$^{D}$ you are conducting tests with.

**Pneumotach Type:** None / MicroTach/ GEM Pneumotach are available options depending on the devices installed.
If you have the Collins BP$^{D}$, select MicroTach.
If you have the Collins BP$^{D}$ configured with the GEM/OWL/HAWK, select GEM Pneumotach.

**Pneumotach Table Number:**
If your system configuration encompasses a pneumotach other than the default MicroTach, a label on the body of the pneumotach will display the number to enter in this field.

**GEM/Owl/Hawk Configuration**

1. Select this tab to configure the Collins GEM, also known as the Owl/Hawk. Since the BP$^{D}$ is a component of the Owl system, you must also select the BP$^{D}$ for configuration if you have the Owl.

**NOTE:**
The term GEM refers to the electronic chassis that is common to the both the Collins Owl and Hawk. The Owl is a diffusion add-on device for the BP$^{D}$ and the Hawk is a stand-alone flow-based pulmonary function testing system. If your system configuration contains either an Owl or a Hawk, click on the GEM tab. The software will deal with each device properly.

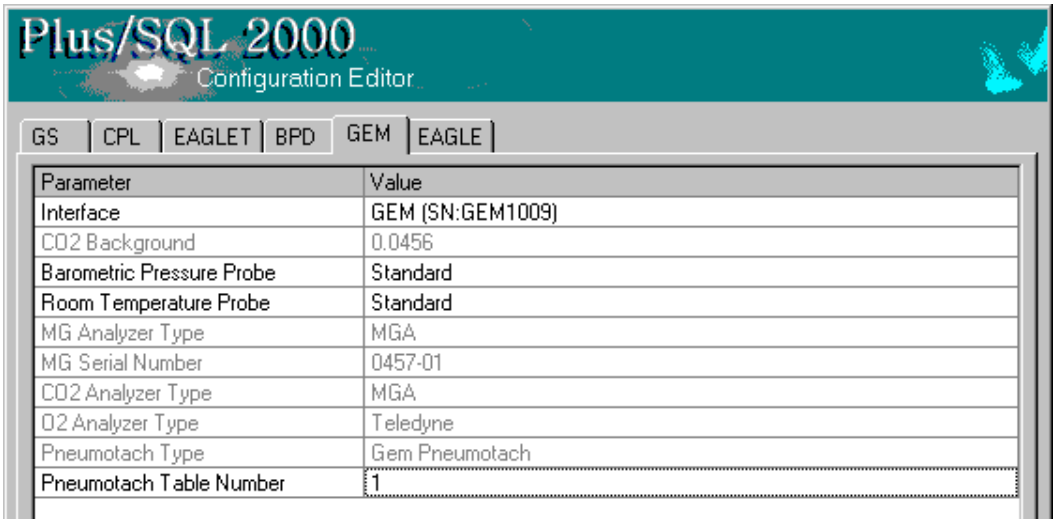



Figure 3-5. Configuration Tab for the Collins GEM

**Interface**: *None / USB*
If you have the Collins GEM, *GEM* and the serial number will be automatically displayed on the line, as shown in the Figure above. If you have more than one GEM connected, the drop-down menu will display these devices along with their respective serial numbers. Select the serial number of the GEM you are conducting tests with.

**Barometric Pressure Probe:** *Standard / None*
The GEM comes equipped with the standard BP probe.

**Room Temperature Probe:** *Standard / None*
The Room Temperature probe determines the temperature corrections used in the software equations. The GEM comes equipped with the standard Room Temperature probe.

**Pneumotach Table Number:**
If your system configuration encompasses a pneumotach other than the default MicroTach, a label on the body of the pneumotach will display the number to enter in this field.

### Eagle Configuration

1. Select this tab to configure the Collins Eagle. The fields are very similar to those for the GEM configuration, described above.

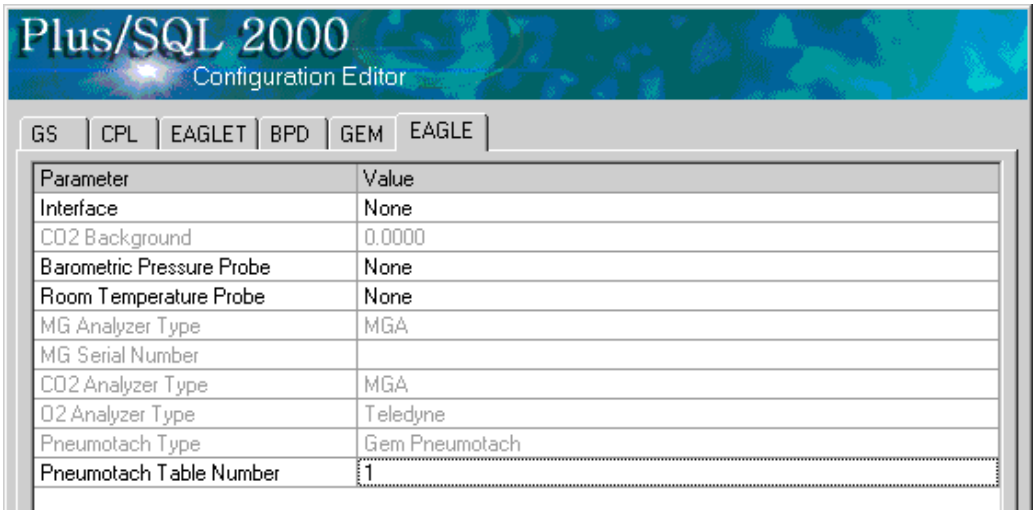



Figure 3-6. Configuration Tab for the Collins Eagle

## The Configuration Editor

1. Select Configuration Editor from the Tools menu in order to configure the various sections of PLUS software.

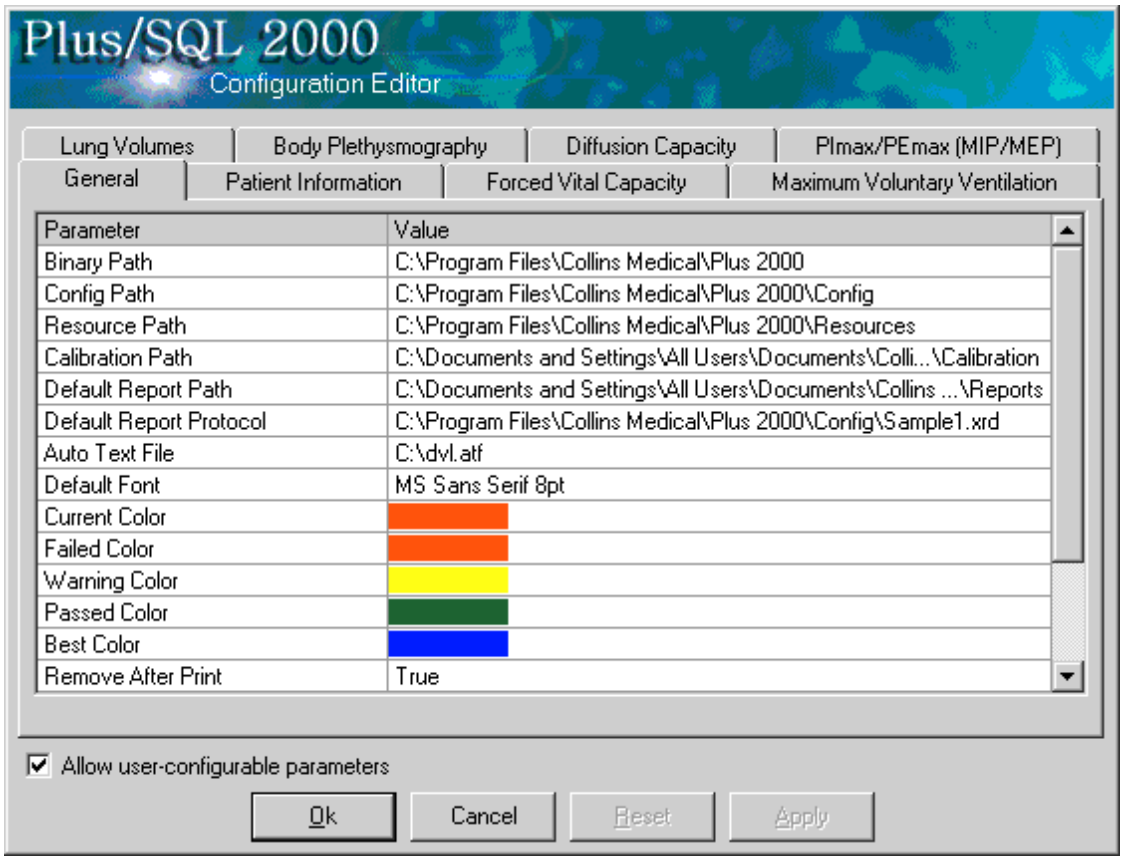



Figure 3-7. The Configuration Editor

## General Configuration

1. Click on the *General* tab. The General Configuration dialog will display. For questions with a box next to them, click on the box to either check it, meaning you want that option, or to uncheck it.

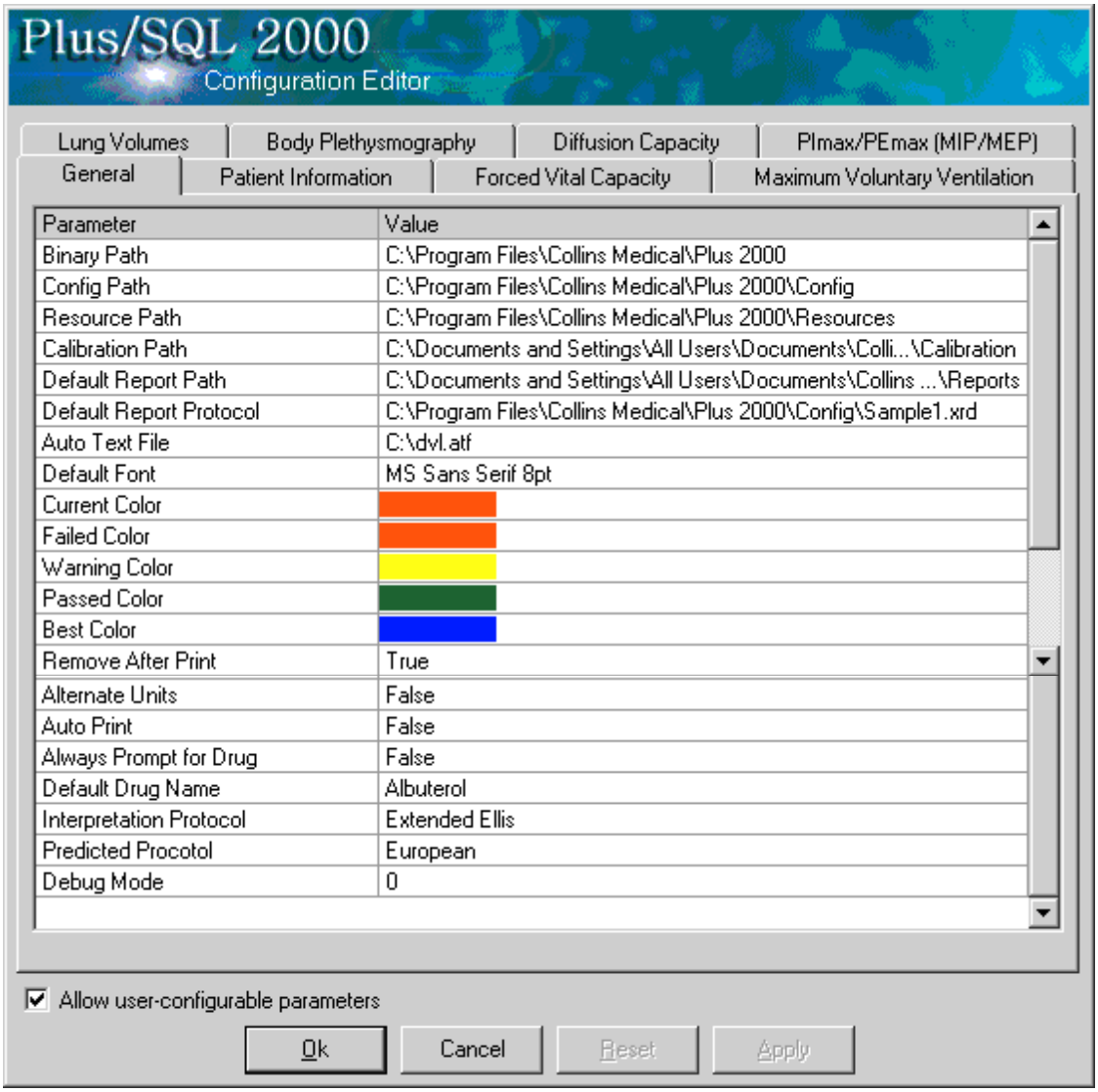



Figure 3-8. The General Configuration Dialog

**Default file locations** are given in the first several lines. The program expects certain files to be stored in a location pointed to by these paths. They should be changed only by people knowledgeable about the inner behavior of the PLUS program.

**Default Report Protocol:** Select the default patient report file to print. This is the report that will print unless you indicate another report file at printing time.

This option will display a dialog where you choose the desired default report file. Click on the *Files of Type* drop-down arrow. You may select a Final (standard) Report (*.frd extension) or an Extended Report (*.xrd extension). Each of these reports is described in its respective Section in the manual.

**Default Font:** Enter the name of the font that you wish to appear by default on various reports. This is the font type that will print unless you change it in the Reports program.

**Current Color:** Refers to the color the program uses in patient tests to highlight the current effort, that is, the one that is being used currently. To change the default of red, double click to get the Windows® color modifying screen.

**Failed Color:** Refers to the color used to highlight an effort or parameter, such as a calibration effort, that has failed. To change the default of red, double click to get the Windows® color modifying screen.

**Warning Color:** Refers to the color used to highlight an effort or parameter that is marginal and should be observed closely in future attempts. To change the default of yellow, double click to get the Windows® color modifying screen.

**Passed Color:** Refers to the color used to highlight an acceptable effort or parameter. To change the default of green, double click to get the Windows® color modifying screen.

**Best Color:** Refers to the color used to highlight the best effort (*Reported Effort*) in a study. To change the default of blue, double click to get the Windows® color modifying screen.

**Remove After Print:** Select *True* for this line if you want the study removed from the cache after it has been printed.

**Alternate Units**: In the United Kingdom, the *Gas Transfer Units*, Tsb and TLCO, reported in mmol/min/kPa (Systeme Internationale Units), are used in place of Dsb and DCO, which are reported in ml/min/mmHg. If you want results converted to Gas Transfer Units, click on *True* for this line.

**Auto Print:** Refers to whether or not you want the worksheet to automatically print after testing.

**Always Prompt for Drug**: Instructs the program to prompt you for the drug name in post-drug testing.

**Default Drug Name:** Allows you to type in the name of the drug you will usually be using for post-drug testing, so that this name will display automatically in the test program. If you do not want a default drug, you may leave this line blank.

**Interpretation Protocol:** Allows you to select the default Interpretation program for the Final Report from among the one supplied by the PLUS program or those created by the User.

**Predicted Protocol:** Click on the down arrow to view the available predicted equation sets provided by the PLUS program.

Collins 1
Collins 2
Collins 3
Collins 4
Crapo CI
European
NHANES3 – AFRICAN-AM
NHANES3 – CAUCASIAN
NHANES3 – MEX-AMER

In the PLUS/2000 Prediction Equations program, you may view a complete listing of each of these sets of equations.
*CI* stands for Confidence Intervals.
The *European Set* uses European terms and measurement units.

2. At the bottom of the screen is a checkbox for *Allow User Configurable Parameters*. If you have Administrative privileges, you may check this box to allow users to override some of these parameters during the test. If you do not want to grant this option, leave it unchecked. This option applies more to the software configuration sections, where for example, the user may wish to change the colors of the tracings during the test for better visibility. However, the tracing colors for the final report would remain the Administrative selection.

3. After making changes for this section, if you wish to return to the original settings, click on Reset. When satisfied with the settings, click on Apply to save them and remain in the Configuration Editor. Click on OK if you wish to save them and leave the Configuration editor. Otherwise, click on Cancel to leave this the program and not save the changes.

**NOTE:**

When you have made a change, that particular parameter will be highlighted in a pale yellow to show the intended changes. When you click on Apply, the highlighted parameters will change back to white to show that they have been saved.

4. These rules for saving and resetting apply to all the Configuration Sections.

**Patient Information Configuration**

1. Click on the Patient Information Tab.

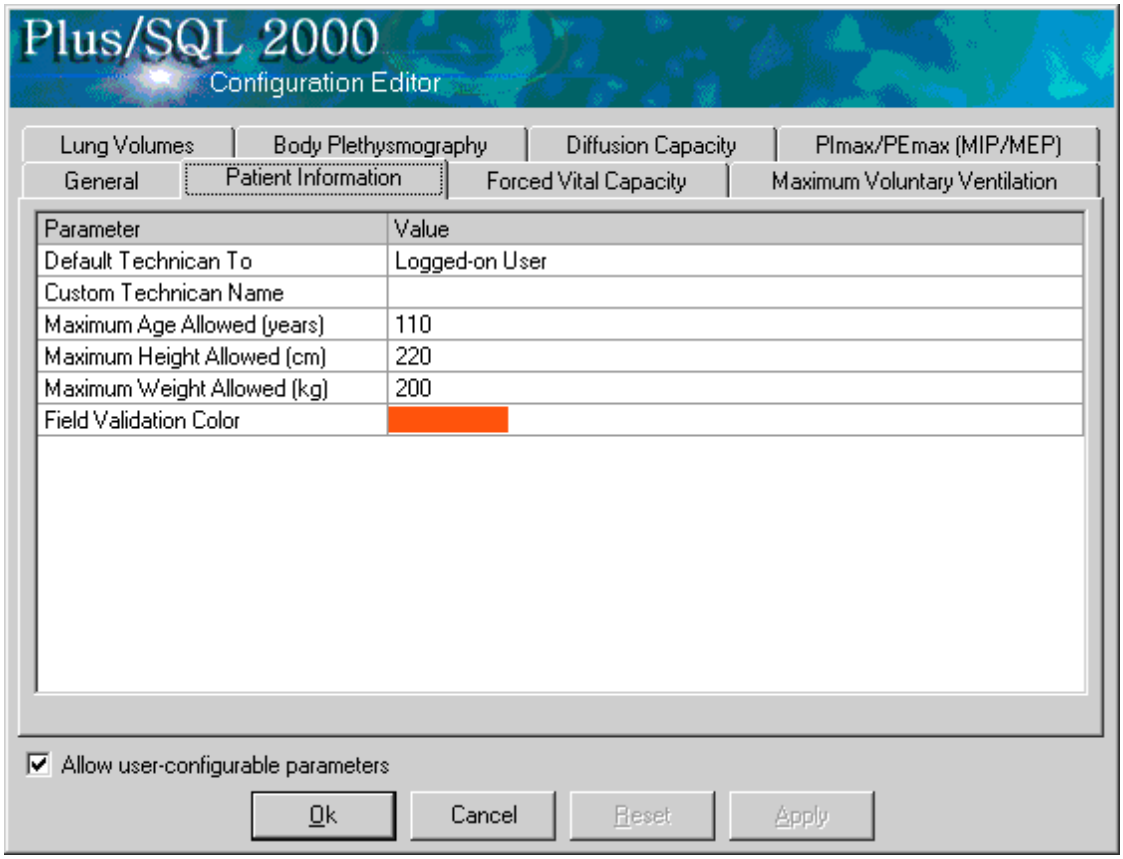



Figure 3-9. The Patient Information Configuration Screen

**Default Technician To:** Click on the down arrow and select either *Logged-on User* or *Custom*. *Logged-on User* will show whoever is currently logged on to the system as the default technician when you're in the Patient Information program. *Custom* will allow you to enter in the name of the default technician on the next line.

**Custom Technician Name:** If you have entered Custom for the previous line, enter in the technician name you wish to appear as the default in the Patient Information program.

**Maximum Age Allowed (years):** Enter in the maximum age you wish the program to accept, for example, 150 (years).

**Maximum Height (cm):** Enter in the maximum height you wish the program to accept, in units entered under the General Tab (inches or cm)

.

**Maximum Weight (kg):** Enter the Maximum Weight you wish the program to accept, in units entered under the General Tab (pounds or kilograms).

**Field Validation Color:** This line will display the default color for signifying that the valid fields have been completed in the Patient Information program. If you wish to change this color, click on it and the standard Windows® color modifying dialog will display.

**Forced Vital Capacity Configuration**

1. Click on the Forced Vital Capacity tab.

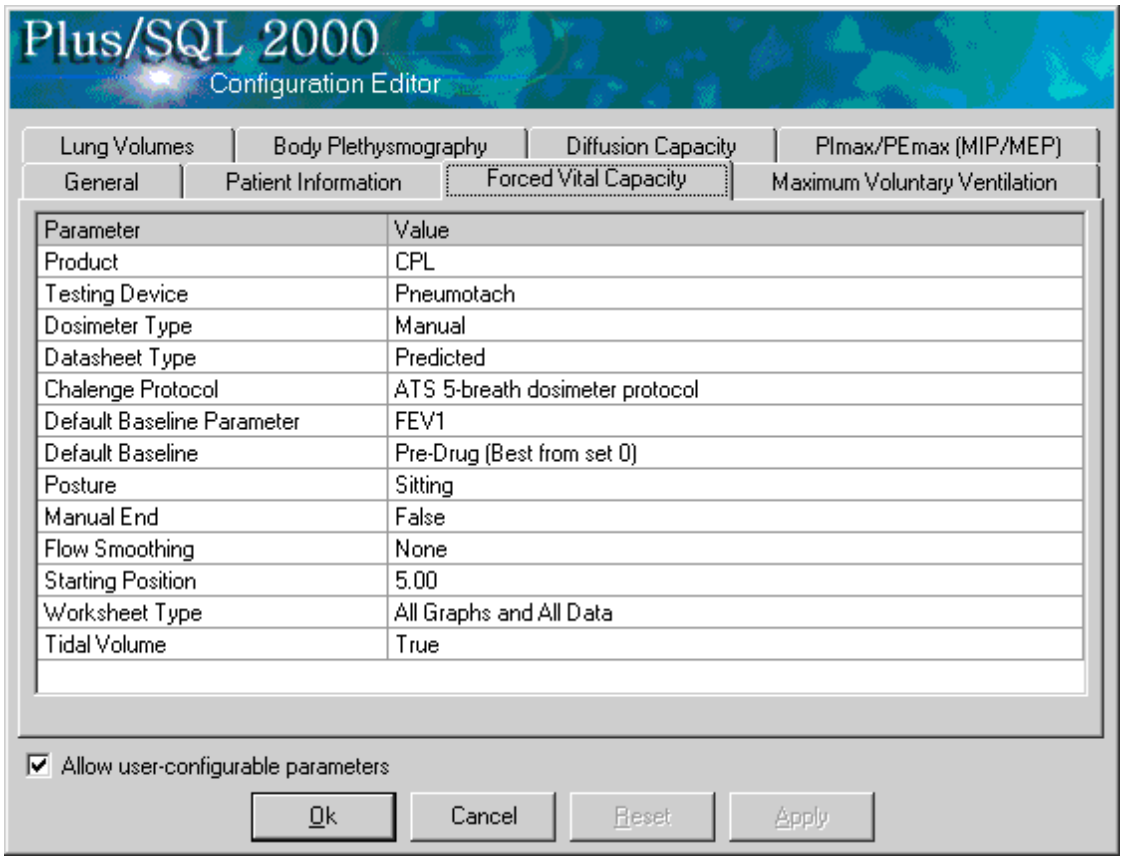



Figure 3-10. The FVC Configuration Screen

2. Most of the options in FVC Configuration involve clicking on the Value box, then on the down arrow in order to see the available options. Then click on the desired option to make your selection.

**Product:**
The product(s) displayed depend on which devices have been identified in Hardware Configuration, for example, the GS, CPL, BPD, GEM, etc. If more than one device is present, select the one on which you wish to conduct FVC testing. If you have the $BP^D$ with the GEM module for diffusion testing, select GEM. What you select for this line will affect what displays for subsequent FVC configuration options.

**Testing Device:** *None / Valve / Pneumotach / Spirometer* **or**
*None / Box Pneumotach or*
*None / GEM Pneumotach*

The options that display for Testing Device depend on what you entered for the Product option. These are just examples. Depending on your system, there could be more or different options.

If using the CPL, enter Valve if you are to be connected to the Balloon Valve during FVC testing. Enter Spirometer if you are to be connected directly to the Spirometer. Enter Pneumotach if connected to the MicroTach. Refer to Preparing the CPL for PFT Testing for more details.

**Dosimeter Type:** *Manual / Automatic*
Enter depending on whether you want manual or automatic operation of the dosimeter. Refer to Dosimeter Control. If you have selected the $BP^D$ or GEM as the Product, *Manual* will be the only option available.

**Datasheet Type:** *Predicted / History*
This refers to the type of data you want to have the datasheet efforts compared to. Selecting Predicted would have all data compared to the patient's predicted values. Selecting History would have data compared to the designated priority (best) pre-drug FVC test from the most recent prior study. What you select here will be the default unless you change it using the right-click menu options at test time.

**Challenge Protocol:**
Click on the down arrow to view the available protocols. Click on the desired protocol.

**Default Baseline Parameter:** *FEV1 / FEF 25%-75% / FEF Max*
Click on the default parameter in which you wish to observe change during the Challenge test. For example, many labs conduct challenge testing until there is a 20% drop in FEV1 with respect to the patient's baseline. The baseline is considered 100% and all other values are a percentage of this value.

**Default Baseline:** *Pre-drug (best from set 0) / Post-Drug (best from set 1)*
Click on the default baseline set that you want to have all post-drug tests compared to in order to measure the percentage change.

*Post-drug* refers to the best effort stored for the first post-drug level. This value could be selected as the baseline if a placebo were administered for the first post-drug level and inhalation of the actual challenge agent was not begun until the second level. The placebo level would be referred to as the Control effort.

*Pre-drug* refers to the best pre-drug effort and would be used if no control were to be conducted in the post-drug phase. Some laboratories conduct both a pre-drug and a control effort and then use the larger of the two.

**Posture:** *Sitting / Lying down / Standing*
Select the posture you want the patient to adopt for the FVC test.

**Manual End:** Check here if you want to end the FVC test manually instead of automatically according to end-of-test criteria.

**Flow Smoothing:** None / ATS (80 msec) / ATS (40 msec).
This option refers to special algorithms used for smoothing data. The default is *None*.

**Starting Position: 5.00**
This refers to the starting level of the spirometer for the FVC maneuver. 5 liters is the default. You may enter in another value if desired.

**Worksheet Type:** Refers to the type of summary you want to print after each test. Click on the down arrow to see the available options, which are:

*None* - no worksheet
*All Data* - a worksheet with all the numerical data for this FVC study
*Current Graph* - a worksheet with just the current graph for this FVC study and no numerical data
*Current Graph and All Data* - a worksheet with just the current graph and all the numerical data for this FVC study.
*All Graphs* - a worksheet with all the graphs for this FVC study
*All Graphs and All Data* - a worksheet with all the graphs and all the numerical data for this FVC study.
*Disability* Graph - a worksheet with a graph acceptable for Social Security disability evaluation and that is acceptable to the American Thoracic Society for performing hand calculations.

**Tidal Volume:**
Enter True if you want the tidal volume tracing to display.

**Maximum Voluntary Ventilation Configuration**

1. Click on the Maximum Voluntary Ventilation tab.

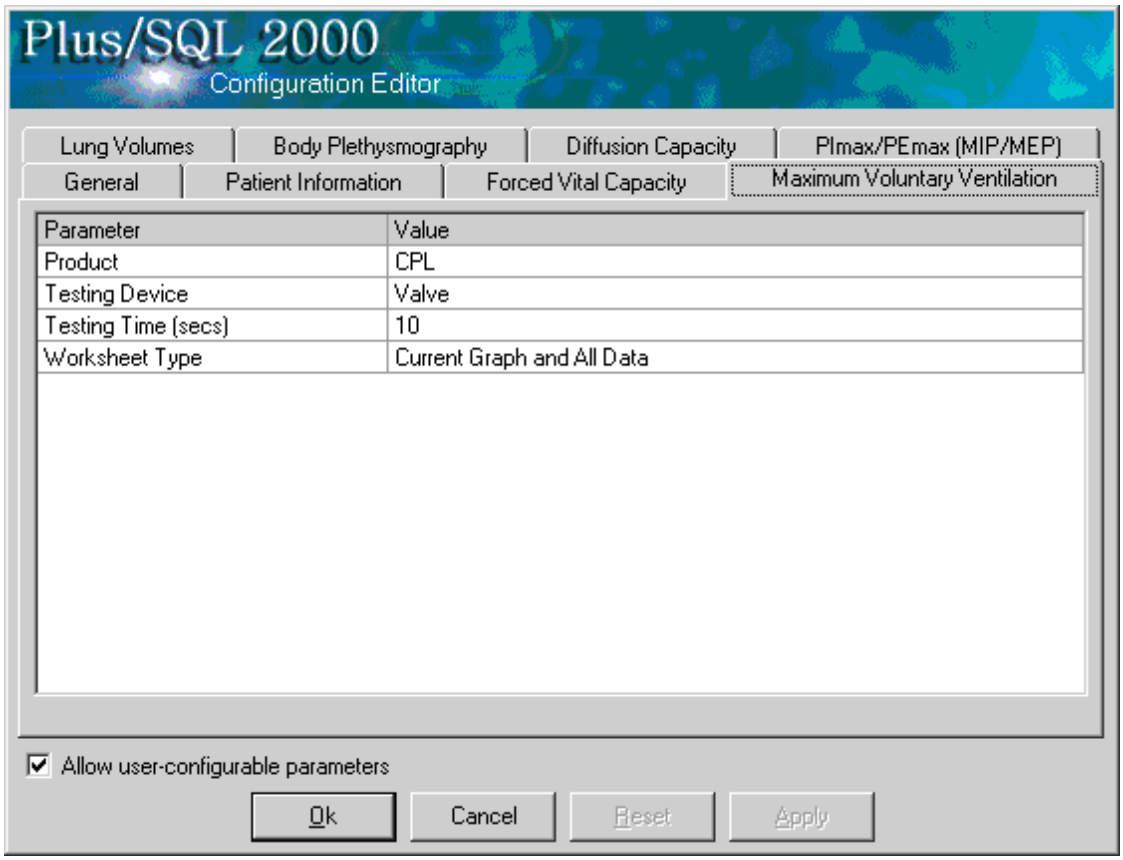



Figure 3-11. The MVV Configuration Screen

Most of the options in MVV Configuration involve clicking on the Value box, then on the down arrow in order to see the available options. Then click on the desired option to make your selection.

**Product:**
The product(s) displayed depend on which devices have been identified in Hardware Configuration, for example, the GS, CPL, BPD, GEM, etc. If more than one device is present, select the one on which you wish to conduct MVV testing. If you have the $BP^D$ with the GEM module, select GEM. What you enter for this line will affect what displays for subsequent MVV configuration options.

**Testing Device:** *None / Valve / Pneumotach / Spirometer* **or**
*None / Box Pneumotach or*
*None / GEM Pneumotach*

The options that display for Testing Device depend on what you entered for the Product option. These are just examples. Depending on your system, there could be more or different options.

If using the CPL, enter Valve if you are to be connected to the Balloon Valve during MVV testing. Enter Spirometer if you are to be connected directly to the Spirometer. Enter Pneumotach if connected to the MicroTach. Refer to Preparing the CPL for PFT Testing for more details.

**Testing Time:** *12*
The default MVV duration time is 12 seconds. ATS recommends that the MVV maneuver last no longer than 15 seconds and no less than 12 seconds, providing the patient can sustain the maneuver. Type in the desired time.

**Worksheet Type:** Refers to the type of summary you want to print after each test. Click on the down arrow to see the available options, which are:

*None* - no worksheet
*All Data* - a worksheet with all the numerical data for this MVV study
*Current Graph* - a worksheet with just the current graph for this MVV study and no numerical data
*Current Graph and All Data* - a worksheet with just the current graph and all the numerical data for this MVV study.

**Lung Volumes Configuration**

**NOTE:**
This option is for the CPL He dilution lung volume software. If you have the Collins Eagle, select the $N_2$ Washout tab to configure the lung volumes test. Refer to the instructions for $N_2$ Washout configuration, which follow this topic.

1. To access this option, click on the Lung Volumes tab.

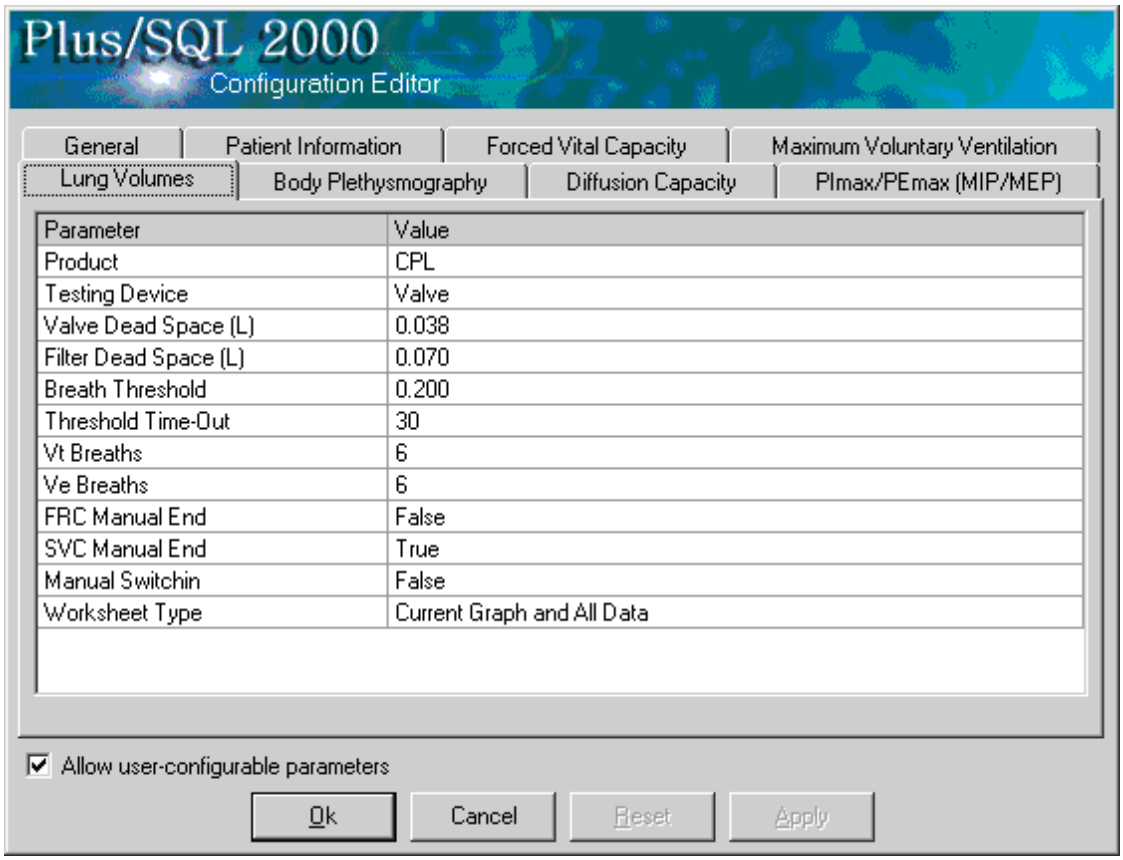



Figure 3-12. Lung Volumes Configuration Screen

2. Some of the options in Lung Volumes Configuration involve clicking on the Value box, then on the down arrow in order to see the available options. Then click on the desired option to make your selection.
3. Lung Volumes Configuration presents the following options:

**Product:**
Select the appropriate device. If it's a USB device, it will be displayed automatically along with the serial number (e.g., CPL SN1004). You must also have this device installed in Hardware Configuration.

**Testing Device:** *Valve / Pneumotach / Spirometer.*
For this option, select Valve.

**Valve Dead Space (L):** *0.038*
Enter the dead space of the Balloon valve (CPL) or UBV (GS), in liters. If you have the CPL, the default is 0.038. Instrument dead space is the part of the breathing network where no gas exchange takes place and must be compensated for in the calculations.

**Filter Dead Space:** *0.070*
If you are using the DC-2 filter between the patient and the patient port during the lung volumes test, the deadspace must be compensated for by the software. The default of 0.070 liters represents the deadspace of the Collins DC-2 filter without a mouthpiece. If using a mouthpiece, you must update the default of 0.070. If using a filter other than the Collins DC-2 filter, it will be necessary to enter in another value. If you are not using a filter, enter 0.

During the actual test, the software will compensate for the deadspace entered using the value entered in Configuration.

**Breath Threshold:** *0.3*
The breath threshold sets the inspiratory flow rate at which the system will detect a breath by the patient. The default value of 300 ml/sec. is acceptable for most patients. You may wish to enter a lower value for patients with very low flows and/or tidal volumes to ensure that the system accurately detects breaths. You may wish to increase this value for patients with very erratic breathing patterns so false breaths are not detected. Always attempt to use the default value first.

Enter a new breath threshold, from 100 to 900 ml/sec, or simply press Enter to retain the default of 300 ml/sec.

**Threshold Time-Out**
If a valid breath, as defined by the previous line, is not detected by the time configured in the Threshold Time-Out line, the program will display a Time-Out message. Enter the desired Threshold Time-Out value in seconds.

**Vt Breaths:** *6*
Enter the number of tidal breaths the patient must perform before conducting the FRC maneuver.

**Ve Breaths:** *6*
Enter the number of expirations the patient must perform before conducting the FRC maneuver.

**FRC Manual End:**
If you want to end the FRC test manually, check here. Otherwise, the test will be automatically ended by the program.

**SVC Manual End:**
If you want to end the SVC portion of the test manually, check here. Otherwise, the test will be automatically ended by the program.

**Manual Switch-in:**
If you want to switch the patient in to the system for the FRC test manually, check here. Otherwise, the program will automatically switch in the patient at the appropriate end-expiration point.

**Worksheet Type:** Refers to the type of summary you want to print after each test. Click on the down arrow to see the available options, which are:

*None* - no worksheet
*All Data* - a worksheet with all the numerical data for this Lung Volumes study
*Current Graph* - a worksheet with just the current graph for this Lung Volumes study and no numerical data
*Current Graph and All Data* - a worksheet with just the current graph and all the numerical data for this Lung Volumes study.

**$N_2$ Washout Configuration**

**NOTE:**
$N_2$ Washout Configuration refers to the type of lung volumes test module supplied by the Collins Eagle system. If you have the Collins CPL, you will have the He dilution module for performing Lung Volume testing. In that case, refer to the preceding instructions for Lung Volumes configuration.

1. To access the test configuration options, click on the *$N_2$ Washout* tab.

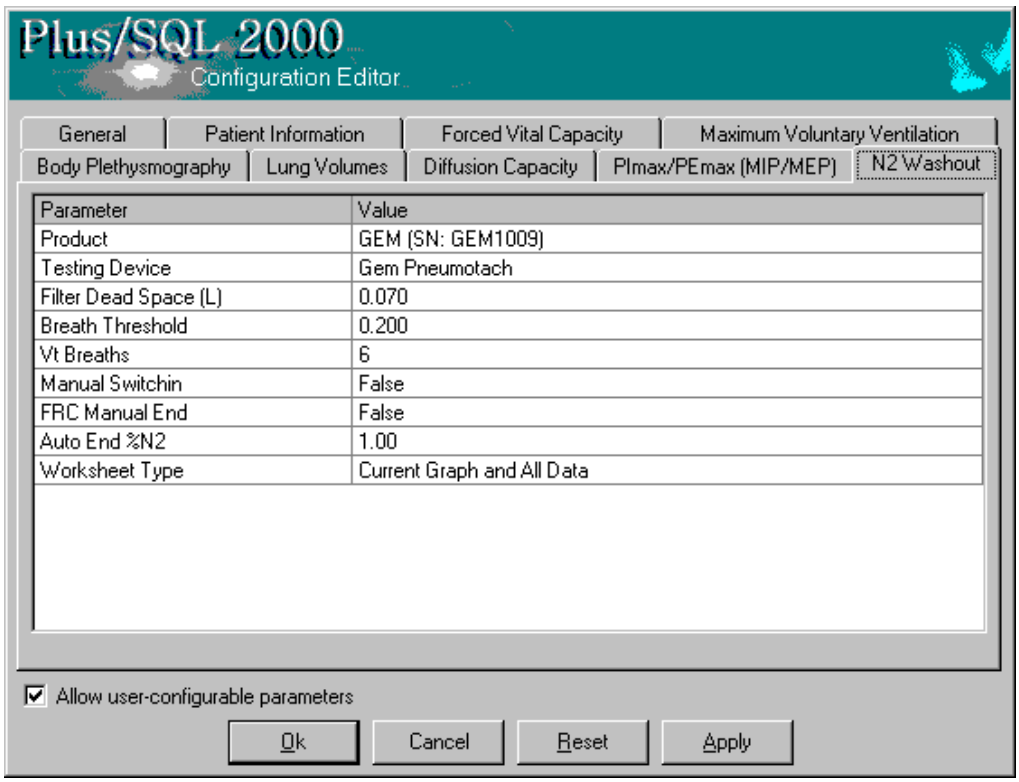



Figure 3-13. The $N_2$ Washout Configuration Screen

2. Some of the options in $N_2$ Washout Configuration involve clicking on the Value box, then on the down arrow in order to see the available options. Then click on the desired option to make your selection.

3. Lung Volumes Configuration presents the following options:

**Product:**
Select the appropriate device, for example, Eagle (or GEM). If it's a USB device, it will be displayed automatically along with the serial number (e.g., CPL SN1004). You must also have this device selected in Hardware Configuration, which is the topic preceding Configuration Editor.

**Testing Device:** *Gem Pneumotach*
For this option, select the GEM Pneumotach.

**Filter Dead Space:** *0.070*
If you are using the DC-2 filter between the patient and the patient port during the $N_2$ Washout test, the deadspace will be compensated for by the software. The default of 0.070 liters represents the deadspace of the Collins DC-2 filter without a mouthpiece. If using a mouthpiece, you must update the default of 0.070. If using a filter other than the Collins DC-2 filter, it will be necessary to enter in another value. If you are not using a filter, enter 0 and no deadspace correction will be made.

During the actual test, the software will compensate for the deadspace entered using the value entered in Configuration.

**Breath Threshold:** *0.2*
The breath threshold sets the inspiratory flow rate at which the system will detect a breath by the patient. The default value of 200 ml/sec. is acceptable for most patients. You may wish to enter a lower value for patients with very low flows and/or tidal volumes to ensure that the system accurately detects breaths. You may wish to increase this value for patients with very erratic breathing patterns so false breaths are not detected. Always attempt to use the default value first.

Enter a new breath threshold, from 100 to 900 ml/sec, or simply press Enter to retain the default of 200 ml/sec.

**Vt Breaths:** *6*
Enter the number of tidal breaths the patient must perform before conducting the $N_2$ washout maneuver.

**Manual Switch-in:** False
If you want to switch the patient in to the system for the FRC test manually, select True. Otherwise, the program will automatically switch in the patient at the appropriate end-expiration point.

**FRC Manual End:** False
If you want to end the FRC test manually, select True. Otherwise, the test will be automatically ended by the program.

**Auto End %N2:** *1%*
If you want the program to end the washout test automatically when the washout tracing reaches a certain percentage, enter that percentage here. The default is 1 percent. This means that when the level of $N_2$ gets down to 1%, the program will end the test automatically. Acceptable values are 1- 3%.

**Worksheet Type:** Refers to the type of summary you want to print after each test. Click on the down arrow to see the available options, which are:

*None* - no worksheet
*All Data* - a worksheet with all the numerical data for this Lung Volumes study
*Current Graph* - a worksheet with just the current graph for this Lung Volumes study and no numerical data
*Current Graph and All Data* - a worksheet with just the current graph and all the numerical data for this Lung Volumes study.

**Diffusion Capacity Configuration**

1. To access the configuration options, click on the Diffusion Capacity tab. Diffusion Capacity is also commonly referred to as the DSB, DCO, DLCO, DLSB and SBD test. If you have selected the European SI prediction equation set in General Configuration, Diffusion Capacity will be reported in Transfer Factor units - TLCO (STPD), mmols/min/kPa, as commonly used in the UK.

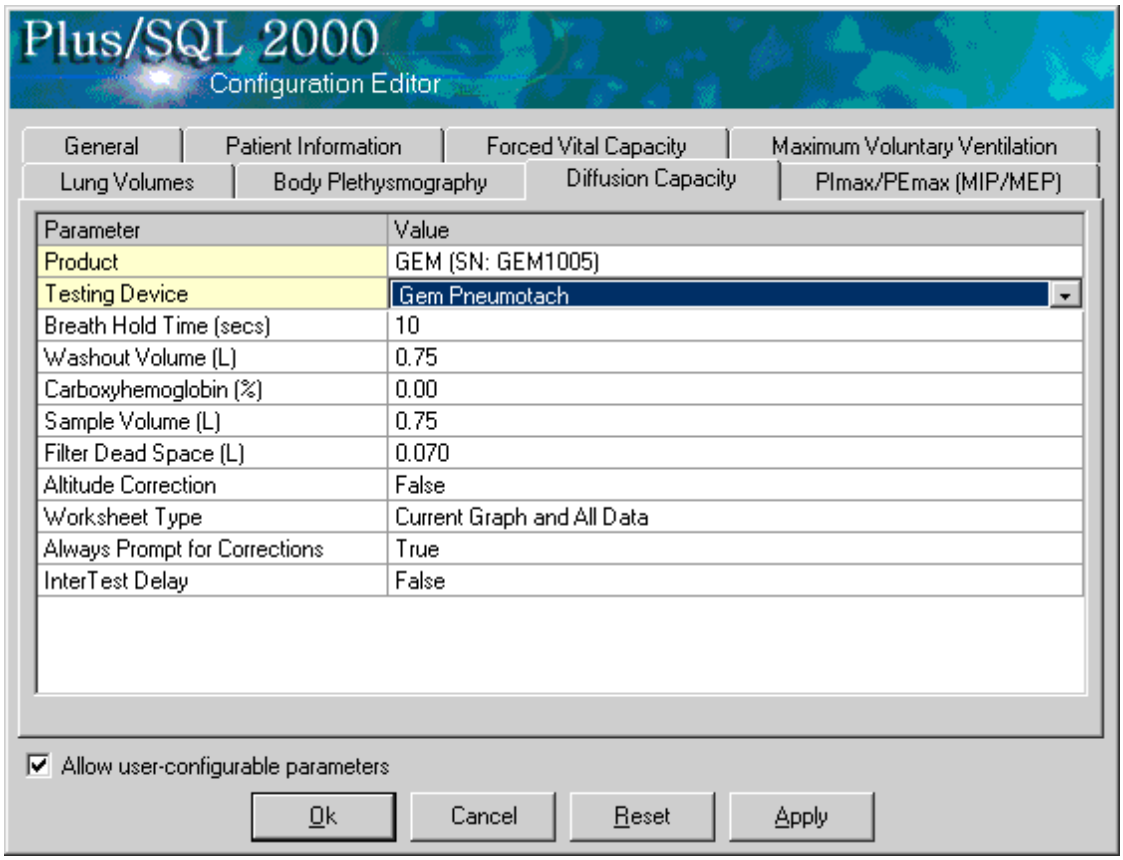



Figure 3-14. Diffusion Capacity Configuration Screen

2. Some of the options in Diffusion Capacity Configuration involve clicking on the Value box, then on the down arrow in order to see the available options. Then click on the desired option to make your selection.

3. Diffusion Capacity Configuration presents the following options:

**Product:**
Select the appropriate device. If it's a USB device, it will be displayed automatically along with the serial number (e.g., GEM SN1005). You must also have this device installed in Hardware Configuration.

**Testing Device:** *Valve / None or GEM Pneumotach / None*
The contents of this line will vary depending on the Product installed in the line above.

**Breath Hold Time (secs):** *10*
The single breath DL maneuver as standardized by the American Thoracic Society requires that the patient perform a rapid inspiration of test gas and hold his breath for 10 seconds prior to exhaling it. Thus the default of 10 seconds displays. However, if you wish to override the 10-second breath hold time, you may do so with a value in the range of 5 to 10 seconds. Type in the desired number.

**Washout Volume (L):** *1.00*
Washout volume represents the volume of air in the conducting airways, where no diffusion occurs; therefore, washout volume is not analyzed in the DL test. ATS recommends taking a washout volume of between 0.75 L and 1.00 L.

In accordance with ATS recommendations, PLUS software will automatically change the washout volume to 0.5 L if the vital capacity for the current patient is less than 2 liters.

Enter a washout volume of between 0.2 and 4.0 liters.

**Carboxyhemoglobin (%):** *0.0*
Enter the %COHB. The DSB test presumes that there is no carbon monoxide in the patient's bloodstream immediately prior to the test. %COHb refers to a correction factor applied to DSB results for patients who already have a certain level of carbon monoxide in the blood, as is the case sometimes with smokers or those who live in very urban areas. Such a value would be determined through arterial blood gas testing.

The value you enter here will be the default value. You will have the opportunity to change this value using the right-click menu options in the actual DSB test program.

**Sample Volume (L):** *0.75*
Enter the expected sample volume.

**Valve Dead Space (L):** *0.038*
Enter the dead space of the Balloon valve (CPL) or UBV (GS), in liters. If you have the CPL, the default will be 0.038. Instrument dead space is the part of the breathing network where no diffusion takes place. Therefore, the software will correct the Volume Inspired during the DSB test by subtracting the value entered here. Refer to About the Dsb Test for more information.

**Filter Dead Space (L):** *0.070*
If you are using the DC-2 filter between the patient and the patient port during the Dsb test, the deadspace must be compensated for by the software. The default value of 0.070 liters represents the deadspace of the Collins DC-2 filter without a mouthpiece. If using a mouthpiece, you must update the default of 0.070. If using a filter other than the Collins DC-2 filter, it will be necessary to enter in another value. If you are not using a filter, enter 0.

During the actual test, the software will compensate for the deadspace entered using the value entered in Configuration.

**Altitude Correction:**
For the Dsb test, an adjustment for altitudes other than sea level may be made by applying a correction equation. Check this box if you want this correction made. Some users prefer to compensate for altitude by correcting the background O2 fraction rather than by applying a mathematical correction.

Applying the correction will be the default. You can change the default from the right-click menu options in the DSB test program.

**Worksheet Type:** Refers to the type of summary you want to print after each test. Click on the down arrow to see the available options, which are:

*None* - no worksheet
*All Data* - a worksheet with all the numerical data for this diffusion study
*Current Graph* - a worksheet with just the current graph for this diffusion study and no numerical data
*Current Graph and All Data* - a worksheet with just the current graph and all the numerical data for this diffusion study.
*Disability* Graph - a worksheet with a graph acceptable for Social Security disability evaluation and that is acceptable to the American Thoracic Society for performing hand calculations

**Always Prompt for Corrections:**
If you want the program to assume the above corrections and not give you a chance to change them once you are in the Diffusion module, answer *False* for this line. However, if you want the program to always prompt you for the corrections while in Diffusion, answer *True*.

**InterTest Delay:**
Enough time must be given between diffusion tests on the same patient in order to clear his/her breathing network of test gasses. If you want to judge this time for yourself during testing, enter False here. If you enter True here, the program will not allow you to conduct another diffusion test until a set amount of time has passed.

**PImax/PEmax (MIPS/MEPS) Configuration**

1. To access this option, click on the PImax/PEmax (MIPS/MEPS) tab.

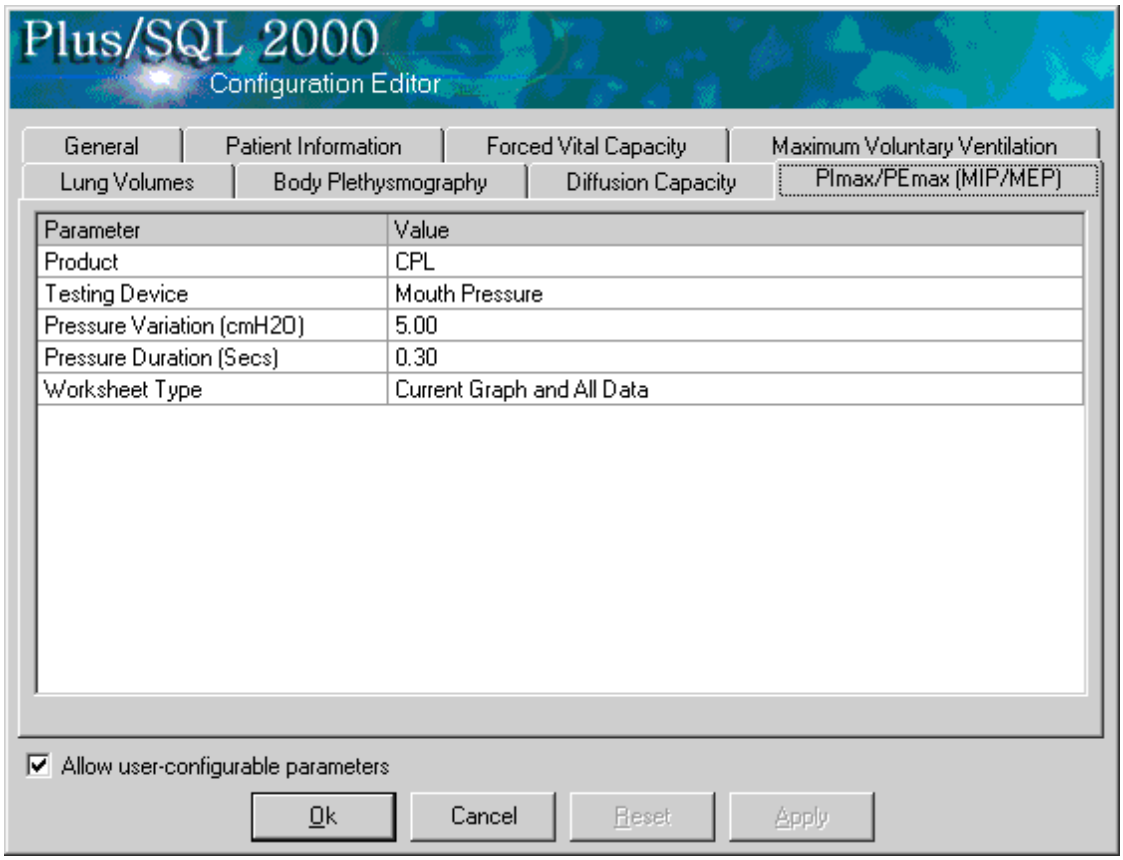



Figure 3-15. The PImax/PEmax Configuration Screen

2. The options are as follows:

**Product:**
Select the appropriate device. If it's a USB device, it will be displayed automatically along with the serial number (e.g., GEM SN1005). You must also have this device installed in Hardware Configuration.

**Testing Device:** *None /Mouth Pressure/Box Mouth Pressure*
The options that display for Testing Device depend on what you entered for the Product option. These are just examples. Depending on your system, there could be more or different options. Select the appropriate device.

**Pressure Variation:** *($cmH_2O$): 5.00*
**Pressure Duration:** *(Secs) 0.30*

*Pressure Duration* refers to the amount of time a pressure must be sustained in order for it to be considered the true PImax or PEmax (also referred to respectively as MIP or MEP). This is in order to avoid mistaking sporadic spikes of pressure as the MIP or MEP.

For Pressure Duration, the software has established a default time of 0.3 seconds. If you wish to make the plateau duration criteria longer or shorter, enter a number from 0.1 to 5 seconds here.

*Pressure Variation* refers to the window of pressure within which the plateau must be sustained in order for the MIP or MEP to be considered valid.

The default for Pressure Variation is 5.00 cmH2O. This means that the maximum pressure must be sustained within a window of +/- 5.00 cmH2O in order to be considered valid. Enter the desired value for this window, from +/- 1.0 to +/- 5.0 cmH20.

**Worksheet Type:** Refers to the type of summary you want to print after each test. Click on the down arrow to see the available options, which are:

*None* - no worksheet
*All Data* - a worksheet with all the numerical data for this MIPS/MEPS study
*Current Graph* - a worksheet with just the current graph for this MIPS/MEPS study and no numerical data
*Current Graph and All Data* - a worksheet with just the current graph and all the numerical data for this MIPS/MEPS study.

**Body Plethysmography Configuration**

1. To select this option, click on the Body Plethysmography tab. Most of the values under Body Plethysmography Configuration will not need changing under normal circumstances. Most changes involve typing in new values.

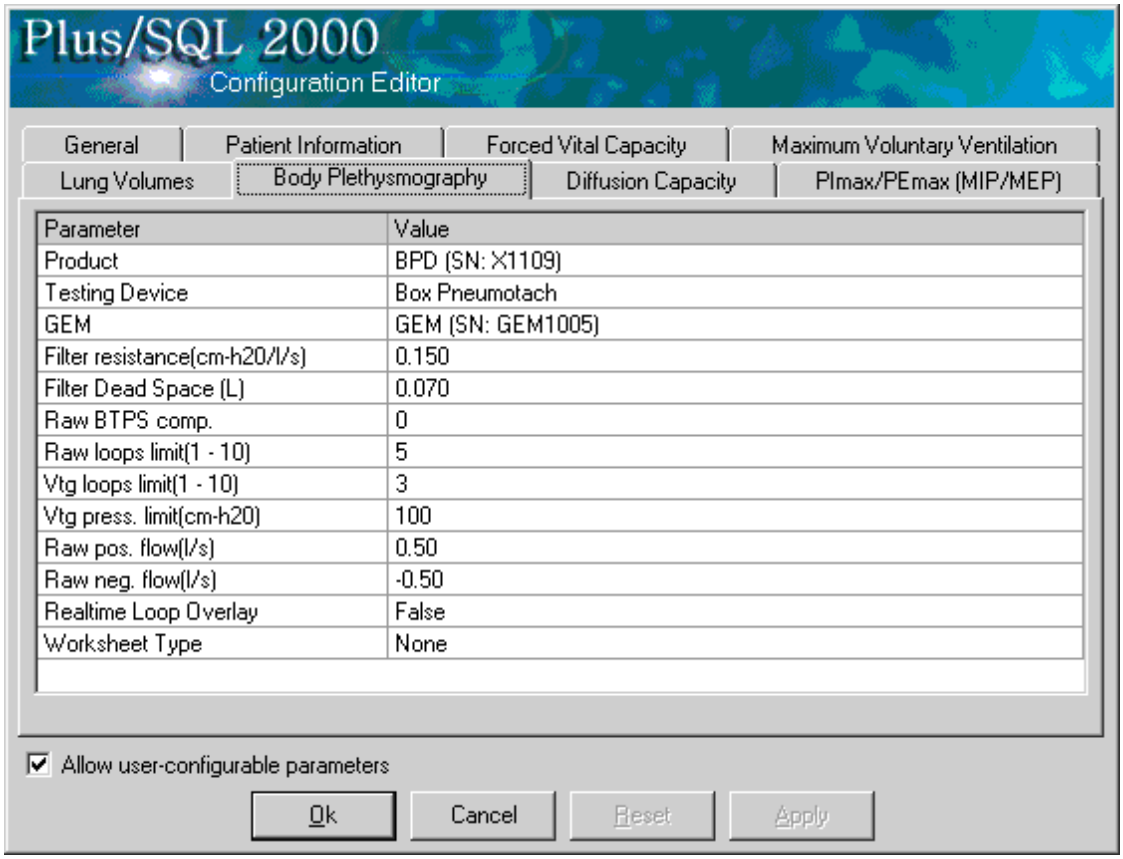



Figure 3-16. The Plethysmography Configuration Screen

2. The options are as follows:

**Product:**
If you have the BP$^D$ plethysmograph connected to the system, this line will display *BP$^D$* and the serial number of the particular device.

**Testing Device**: Box Pneumotach / None
The testing device is the *Box Pneumotach*.

**GEM:**
If you have the Collins GEM for diffusion testing connected to the $BP^D$, this line will display *GEM* and the serial number of the particular device.

**Filter resistance (cm-h20l/s):** 0.200
It will be necessary to change this value if using other than the Collins DC-2 filter.

**Filter Deadspace (L):** 0.070
The default value of 0.070 liters represents the deadspace of the Collins DC-2 filter without a mouthpiece. If using a mouthpiece, you must update the default of 0.070. If using a filter other than the Collins DC-2 filter, it will be necessary to enter in another value. If you are not using a filter, enter 0.

During the actual test, the software will compensate for the deadspace entered using the value entered in Configuration.

**Raw BTPS Comp:** 0
Enter a value here if you want the Raw BTPS to be compensated automatically. The default is zero compensation. However, you will have an opportunity during the test Review procedure to compensate individually.

**Raw loops limit (1-10):** 5
Enter the highest number of Raw loops you want recorded from each maneuver, from 1 to 10. Each loop represents a sequence of 4 panting breaths.

**Vtg loops limit (1-10):** 3
Enter the highest number of Vtg loops you want recorded from each maneuver, from 1 to 10. Each loop represents one panting cycle (1 breath in and 1 breath out) against the closed shutter.

**Vtg press. limit (cm-h2O):** 100
Enter the pressure at which you would want the mouth shutter to open during the VTG maneuver. This is a safety feature of the system which would be activated if, for example, the patient were to cough while on the shutter.

**Raw pos. flow (l/s):** 0.50
**Raw neg. flow (l/s):** -0.50
These numbers indicate the upper and lower flow limits between which the program will establish the Raw angle. Dotted lines representing these values will be present on the Raw graph. You may change the defaults of 0.50 and -0.50 l/sec here.

**Realtime Loop Overlay:** False / True
If you answer False to this option, the program will display just the most consistent loops out of every sampling during the Raw review. If you select True, you will see all the loops from each sampling. Each selected loop will be superimposed in blue over the other "shadow" loops in that sampling.

**Worksheet Type:** Refers to the type of summary you want to print after each test. Click on the down arrow to see the available options, which are:

*None* - no worksheet
*All Data* - a worksheet with all the numerical data for this BP study
*Current Graph* - a worksheet with just the current graph for this BP study and no numerical data
*Current Graph and All Data* - a worksheet with just the current graph and all the numerical data for this BP study.

**FVC Challenge Editor**

1. This option allows you to configure protocols for conducting FVC challenge tests. What you enter for the challenge protocol controls operation of the Collins Dosimeter, the device used to administer preset amounts of a drug dosage for a preset amount of time during the challenge test.

2. Select *Tools*, then *Challenge Editor*. The program will display a list of the existing challenge protocols. The default, the ATS 5-Breath Dosimeter Protocol, is configured for your convenience. When you click on a protocol to select it, the information will display in the boxes and charts below the list.

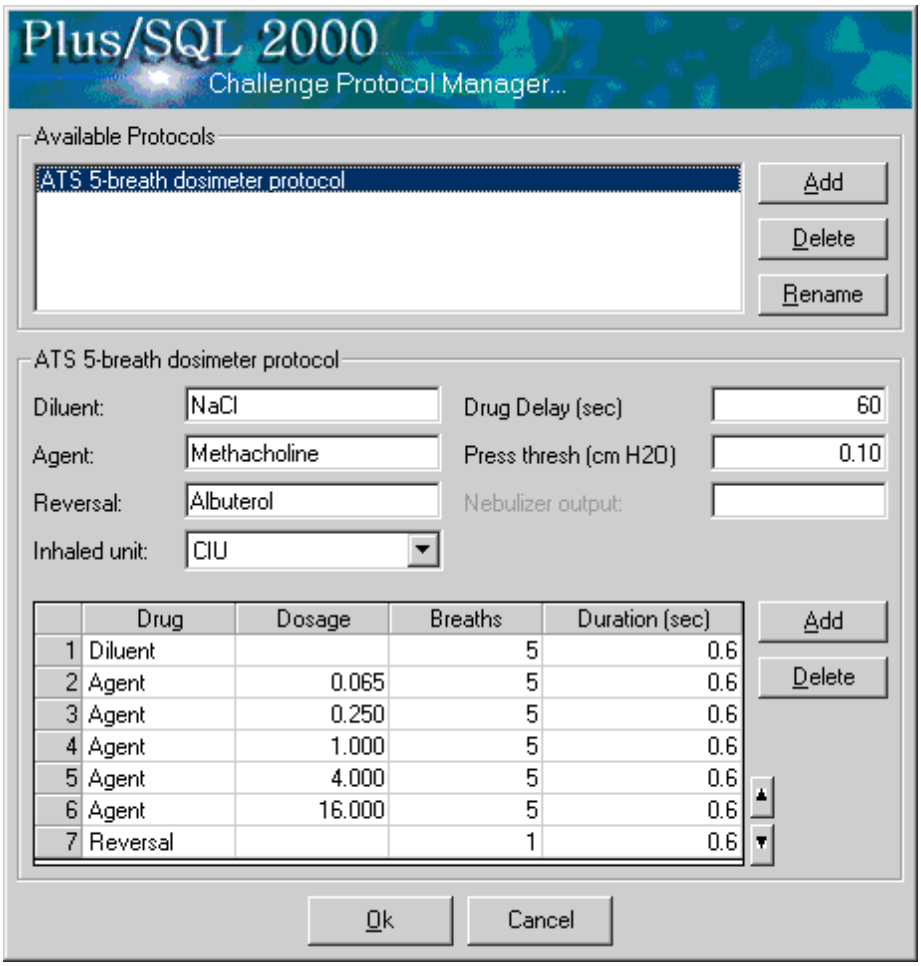



Figure 3-17. FVC Challenge Editor

3. To create a new protocol, click on Add, to the right of the protocol list. The list will display Protocol 2. To rename this or another protocol, highlight the name, click on Rename and enter another name in its place.

4. Fill in the information boxes below the list for this protocol. To move from box to box, use the Tab key.

   **Diluent:** Enter the name of the Diluent that will be used, for example, NaCl. The diluent is the substance the challenge agent is mixed with.

   **Agent:** Enter the Challenge Agent, for example, Methacholine.

   **Reversal:** When challenge testing is completed, it is customary to administer a bronchodilator in order to reverse the effects of the challenge agent. Enter the name of the Reversal agent, for example, Proventil.

**Inhaled Unit:** The options for this line are cumulative inhalation units (ciu), or micromoles (µmoles). Display these options by clicking on the down arrow.

**ciu:** If you are using the Collins Dosimeter option, then use ciu if you want to activate the dosimeter during inspiration only. When you select ciu, the program will display the message:

*Changing inhaled unit to ciu will reset all levels to 5 breaths and 0.6 sec. delay. Continue?*
The protocol referred to in this message is in keeping with ATS guidelines for challenge testing. Answer *Yes* to this message if you are using the Collins Dosimeter option. You may change these default settings later on as you create levels for your protocol.

**NOTE:**

One inhalation unit is equal to 1 inhalation of a 1 mg per ml concentration of the challenge agent. Therefore, to arrive at cumulative inhalation units, the drug dosage is multiplied by the number of breaths for that level. The same is done for the next level, which is then added to the previous level, and so on.

**µmoles:** use µmoles if you wish to use continuous nebulization. When you select µmoles, the following message will display:

*Changing inhaled unit to µmole will reset all levels to 0 breaths and 120 sec. Delay. Continue?*

Answer *Yes* to this message if you want continuous nebulization.

**Delay:** Refers to the amount of time the dosimeter counts down from the point of completing a drug dosage to the beginning of the test. Enter the desired time in seconds or simply retain the default.

**Pressure Threshold:** This line displays the system's current sensitivity to detecting the inspiration that begins a breath. Enter the desired Pressure Threshold in $cmH_2O$ or simply retain the default.

**Nebulizer Output:** This applies only if you have selected µmoles as the Inhaled Units. Refer to Determining Nebulizer Output to obtain this value and enter it in this box. Remember, when using µmoles, the Nebulizer Output must always be entered.

5. Proceed to the chart at the bottom of the dialog to configure each level of challenge for your protocol.

**NOTE:**

If using µmoles, when the nebulizer output is entered above and you start creating levels, the number of breaths in the chart will read 0 for all levels. Do not change this, because if using µmoles, you cannot utilize the Dosimeter option for activation based on breaths, but only for continuous nebulization.

6. Before a level of challenge tests is conducted, the dosimeter will administer the challenge agent as specified in the challenge protocol for the current dosage level. With ciu, the drug dosage (*Concentration*) will be administered during inspiration for the indicated time (*Duration*) for each breath specified (*Number of Breaths*).

**NOTE:**

The protocol recommended by the American Thoracic Society calls for the administration of doubling concentrations of challenge agent in five-breath increments. A placebo (no provocative agent) step using NaCl or the drug diluent is often used prior to the first drug level and inhalation of the actual challenge agent not begun until the second level. In this case, the first challenge level may be used as the control as opposed to the pre-drug level.

7. Click the *Add* button next to the Chart to get the first level.

8. For Level #1, click on the down arrow in the *Drug* column and select the type of level: *Diluent/Agent/Reversal.* If the first

level is to be a placebo step, enter *Diluent*. For a placebo level, always leave the Dosage column blank or enter zero so that the placebo level will not be included in the cumulative data.

9. In the next columns, enter the *Number of Breaths* of placebo to be inhaled and the *Duration* in seconds of each breath.

10. Click on *Add* to add the next level. Level #2 will display in the next row. Select *Agent* for the Drug.

11. Double-click in the *Dosage* box, the type in the drug concentration in mg./ml. For example, if you administer 0.075 mg/ml of methacholine, you would enter 0.075.

12. Enter in the number of *Breaths* for that drug concentration, for example, 5.

13. For *Duration*, enter in a value between 0.1 and 10.0 seconds. (In general, 0.6 seconds is most commonly used).

**NOTE:**

As mentioned above, if you have selected ciu for inhalation units, the breaths and delay will default to 5 and 0.6 seconds respectively. You may change these defaults if you wish.

14. Fill in the information for the rest of the drug levels, up to 20. If you add more levels than will fit on the window, you may use the scroll bar to scroll up and down the chart.

**NOTE:**

Skipping ahead in the protocol during the actual test will not work if the number of configured breaths vary.

15. You may enter *Reversal* for the drug in the last challenge level. As with the *Diluent* level, enter nothing or zero for the *Dosage* so that the data for the reversal level will not be included in the cumulative data. Then enter in the *Number of Breaths* and *Duration* of the reversal level.

16. To remove a level of challenge, highlight it and click on Delete.

17. When finished configuring a protocol, click *OK* at the opening Challenge Configuration window to save it. Otherwise, click *Cancel*.

18. To delete a protocol, at the opening Challenge Configuration window, highlight the protocol name in the list and click on *Delete*.

19. In order to conduct a challenge test, or to find out more about challenge testing, refer to *FVC Challenge Testing* in Section Five.

*Determining Nebulizer Output*

1. When using µmoles as the Inhaled Units in the FVC Challenge Configuration, Nebulizer Output must always be entered. The actual output of solution by the nebulizer is determined in the following steps:

2. Fill the nebulizer/dosimeter with some volume of saline solution and weigh it (in grams).

3. Activate the nebulizer for the period of time that it will be activated during the challenge protocol. Re-weigh the nebulizer with the remaining solution. Make a note of the difference in weight from before and after nebulization (weight before - weight after).

**NOTE:**

Good laboratory weighing practices must be followed to ensure accuracy and precision.

4. Take the difference in weight (amount nebulized in grams) and divide this number by the density of the solution (e.g., water = 1 gm/ml, seawater = 1.03 gm/ml). This will give you the volume (in ml) of nebulized solution. Divide this number by the molecular weight of the challenge substance.

5. Multiply this number by $10^3$ (1,000) to get $^{(ml * \mu moles)}/_{mg}$ . Enter this number for the Nebulizer Output in FVC Challenge Configuration.

## System Security

**NOTE:**

Due to certain restrictions imposed by Microsoft, Inc. on standard users, any PLUS user must belong to either

The Power Users Group on the local computer

or

The Administrators Group on the local computer

1. The Security feature is for controlling levels of access to patient data and system control for different groups of personnel. PLUS 2000 Security may be integrated with Windows® 2000 security resources (refer to *Database Selection*, which is also in this section), in which case accounts for administrators and users can be created from within Windows® 2000. Refer to your Windows® documentation for more details. In the following discussion we will assume that the two Security systems are integrated.

2. When you select *Security* from the *Tools* menu, the program will display three default security groups in the top dialog panel as shown in Figure 3-14. Members of the groups in this list have been granted varying rights within the PLUS program. The program identifies you as belonging to one of these groups according to your Log-in ID and Password at startup.

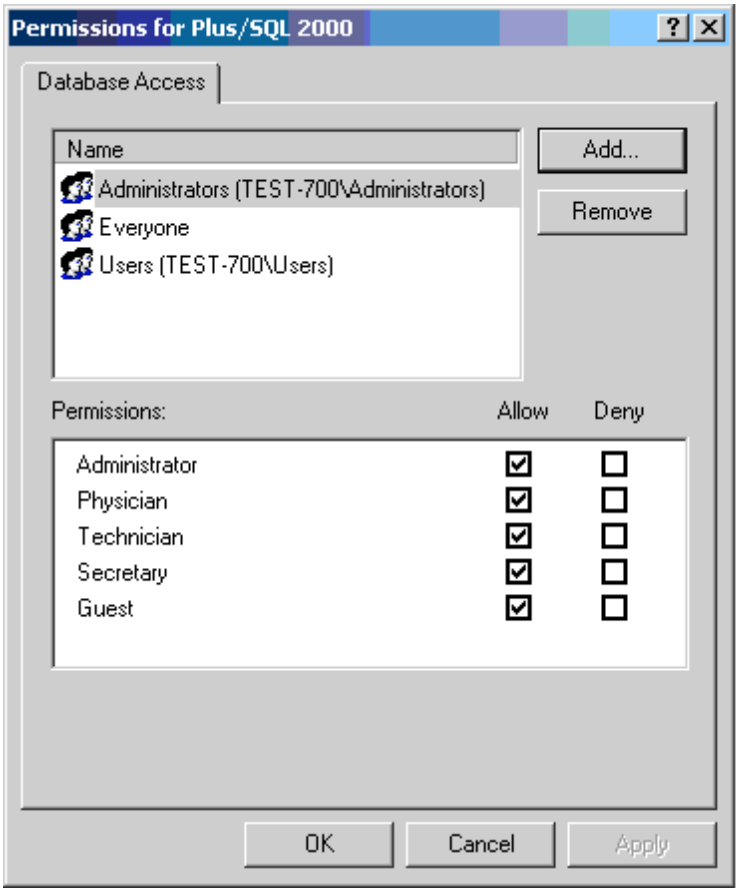



Figure 3-18. The System Security Dialog

3. The icon next to each group indicates whether the group is an individual, a group of individuals, or a computer, as shown in Figure 3-15.

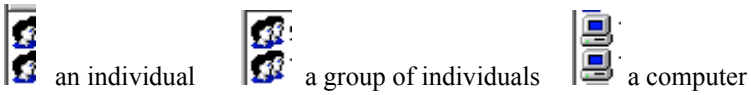



Figure 3-19. Icons used in Security Dialog

4. As you highlight each group, the lower panel will display the levels of permissions this group has by default. These levels are defined as follows:

   **Administrator** -- Has all system permissions. In other words, the Administrator may review test data, administer tests, configure the system, conduct Database Utilities, assign levels of Security.
   **Physician** - Is allowed all permissions of Secretary plus Technician
   **Technician** - Allowed to perform tests, enter patient data, manage the local workstation cache. Has no Database Utility or Security permissions.
   **Secretary** - Allowed to create patients and assign them to caches, manage local and remote workstation caches, produce and print Final Reports. Not allowed to conduct or view tests; no DB or Security permissions.
   **Guest** - Can read but not manipulate any data.

5. The PLUS program default is for the Administrator group to allow all levels of permission. The Everyone group has just Guest permissions. The Users group has Guest and Technician permissions.

6. If you are an Administrator, you may add or remove permissions for each group by clicking on the *Allow* and *Deny* boxes beside the permission levels. The *Deny* button allows you to deny a permission to a member that may have been granted this permission level in another group.

**NOTE:**

You may belong to more than one group on the list, with different levels of permissions granted to each. In this case, the system allows you just the lowest level of permissions. For example if groups A, B and C allow you Administrator, Secretary and Guest permissions respectively, you will only be allowed Guest permissions when using the PLUS system.

7. You may add more permissions groups to the default list by clicking *Add*. A table will display listing all the available groups registered by Windows® 2000. The *Look In* option allows you to search for a group in a different folder. In the example shown in Figure 3-16, we have selected the folder *testing plussql.com*. The groups from this folder will display.

8. Highlight the desired group; then click on *Add*. The name will display in the lower panel. For example, click on *Domain Computers* and then on *Add*.

9. Click on *Check Names* if you wish to make sure that the name selected is registered in Windows® 2000.

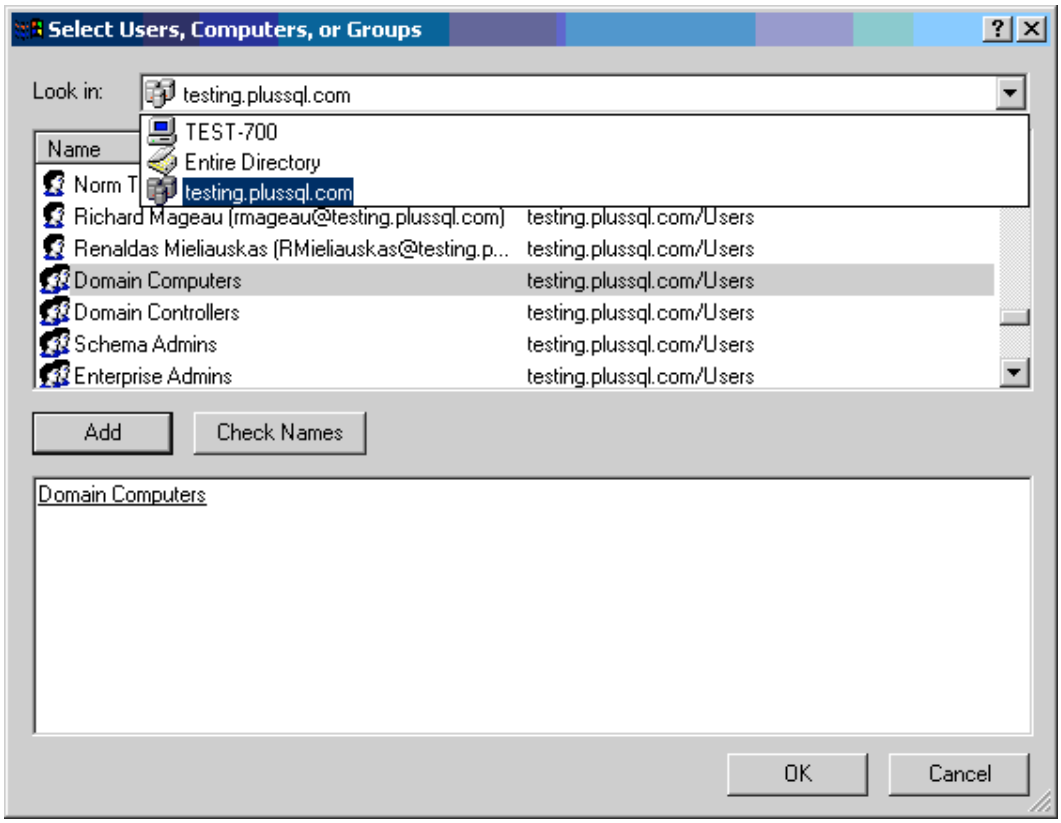



Figure 3-20. Adding a Group to the Security List

10. Do this for as many groups as you wish to add to the security list. Then click OK. The program will return to the opening Security screen, where you will see the new groups among those listed on the top panel. These groups now have permissions within the PLUS system. Highlighting each one in turn will display the permissions assigned to them in the lower panel.

11. You may remove a group from the Security List by highlighting it and clicking *Remove*.

12. The changes you have made in Security will take effect when you click on Apply. When done, click on OK to exit the Security dialog.

## Database Selection

1. A database may be selected by choosing Open Database from the File menu while at the Patient Information screen. The Database Connection window will display.

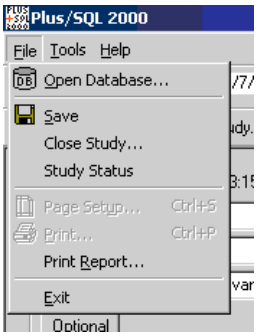



Figure 3-21. The Open Database Option on the File Menu

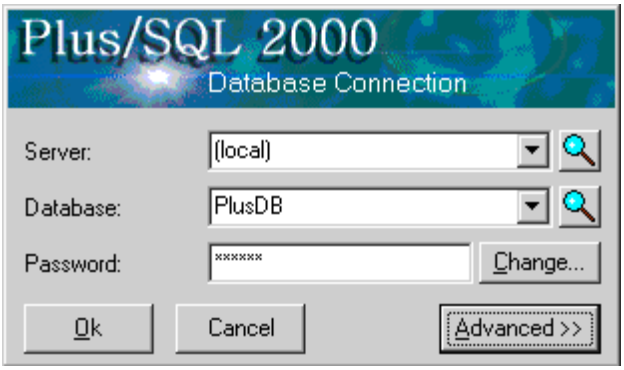



Figure 3-22. The Database Connection Dialog

**Server:** Enter the name of the server on which the desired database is located or click on the down arrow to select it from the list. To scan the system for a list of available servers, click on the magnifying glass icon.

**Database:** Enter the name of the database you wish to use or click on the down arrow to select it from the list. To scan for a list of available databases, click on the magnifying glass icon.

**Password:** Enter the password required to access this database.

If you have the appropriate level of security permission, the program will display a button to the right to let you change this password.

2. The password you entered above is a Windows® 2000 password. If this password is sufficient for accessing the PLUS database, you may end here and click OK. In this mode, all PLUS security is subsumed under and handled as part of the overall Windows® 2000 security. Integrating PLUS security into Windows® security simplifies security administration.

3. However, if you do not have Integrated PLUS/2000 Security, click on Advanced to enter more information. Another pane will display below the original one.

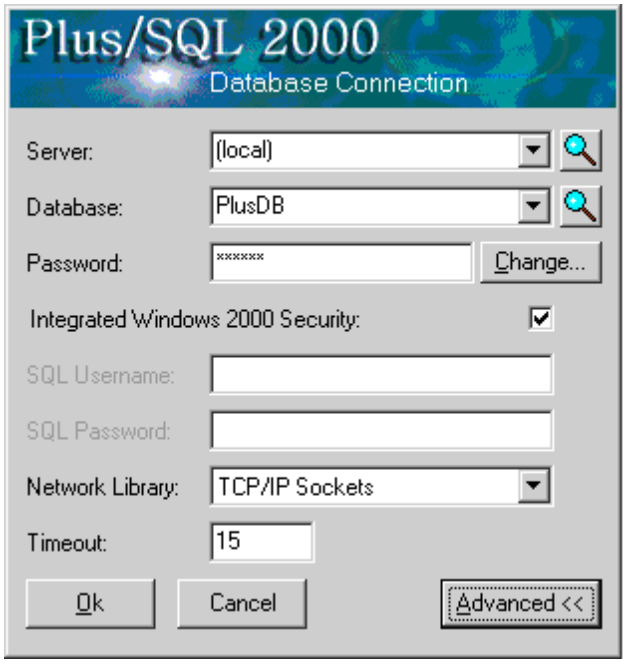



Figure 3-23. The Advanced Database Connection Dialog

**Integrated Windows® 2000 Security checkbox:**
If this box is checked, you have integrated PLUS and Windows® security and there is no need to enter further passwords. If checked, the next two options will be grayed out since they don't apply. However, if not checked, you must enter further information:

**SQL Username:** Enter the SQL user name for the specified database.

**SQL Password:** Enter the SQL password for the specified database.

**Network Library:** Enter the name of the desired Network Library or click on the down arrow to select one from the list.

**Timeout:** Enter the number of seconds to allow the system to make the database connection before displaying an error message.

4. When done, click on OK or click on Advanced to return to the original window. When finished with the entire window, click OK to close the dialog box.

**NOTE:**
In the event that PLUS/2000 security is not integrated with Windows® 2000 security, these added options are necessary to access the SQL 7.0 database, which has its own security system, independent of Windows®.

## Code Editor

1. The *Code Editor* allows you to create and edit drop-down lists for use in certain options of the PLUS program. To access this function, click on *Tools*, then *Code Editor*.

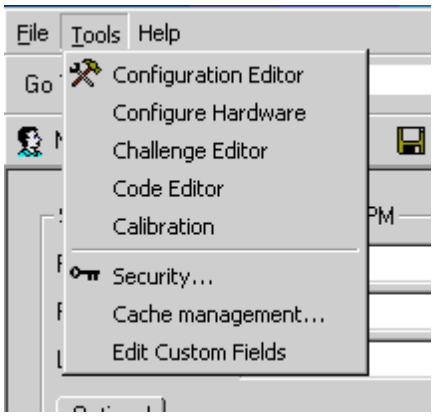



Figure 3-24. Selecting the *Code Editor* Option from the Tools Menu

2. The *Code Editor* dialog will display. Click on the drop-down menu to select a list category.

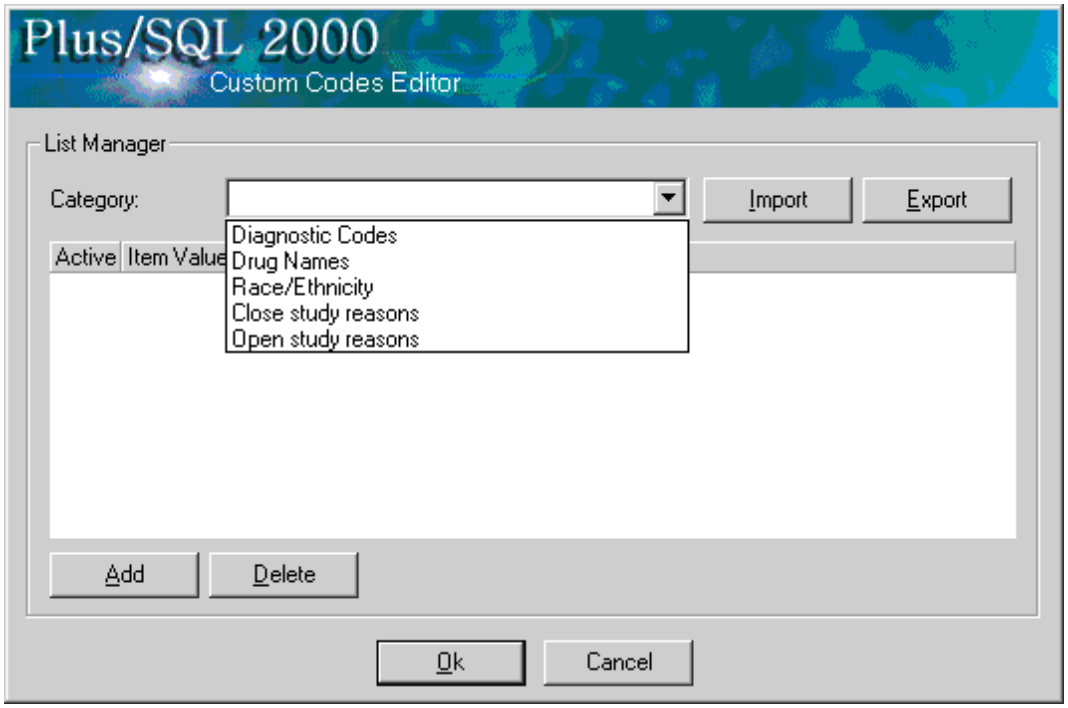



Figure 3-25. The Code Editor Dialog

2. Definitions for the default categories are as follows:

**Diagnostic Codes –** Refers to the pop-up list for the Diagnoses field in the Patient Information program. While in Patient Information, click on the button next to Diagnosis view this list and select from it.

**Drug Names** - Refers to the drop-down list of Drug Names in the FVC Challenge phase of the PLUS program. When you click on the Drug option in the Challenge phase, the program will display this list.

**Race/Ethnicity** - Refers to the drop-down list for the Race category in the Patient Information dialog. While in Patient Information, clicking on the down arrow next to Race will produce this list, from which you may choose a race or ethnicity.

**Close Study Reasons** - This is the list that will display in the Close Study dialog, available from the File menu. When closing a study, you must give a reason for closing. Refer *to Closing and Opening Studies* in Section Two.

**Open Study Reasons** - This is the list that will appear in the Open Study dialog, available from the File menu.

3. Double-click on a list category to select it, for example, *Race/Ethnicity*. The program will display the *Race/Ethnicity* list.

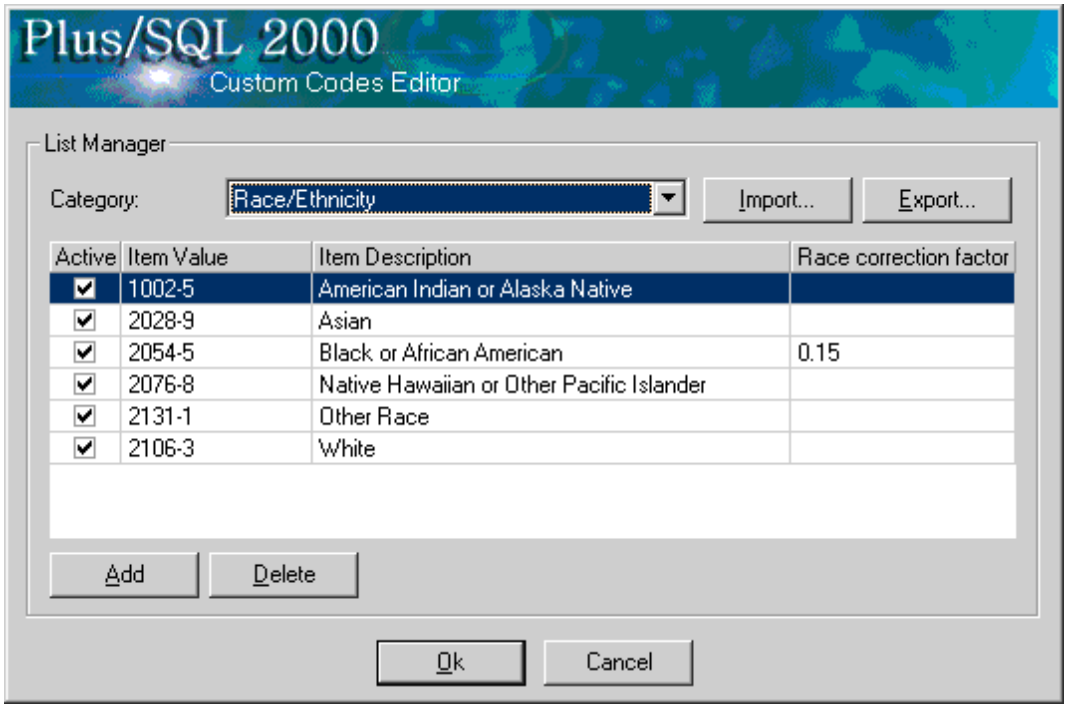



Figure 3-26. Sample List for the Code Editor

4. To add another *Race/Ethnicity* category to this list, click *Add* and a blank row will display. Fill in the column headings as follows:

   Click on the box in the first column. A check mark will make this line active; no check mark means it's inactive. Making a line inactive does not mean it's been deleted (see the discussion of the *Delete* option, further on in this topic). For example, for the Race list, if you make *White* inactive, the category will still exist, but it will be missing from the *Race* list on the *Patient Information* screen. You will have to exit the *Patient Information* dialog and then return in order to see that the line is inactive.

   Enter the *Item Value* in the next column. Collins uses the standard HL-7 codes for the Race/Ethnicity list.

   Enter the description of the category, such as *Black or African American*.

   Enter a race correction factor, if any is associated with this category. The default *for Black or African American* is 0.15, since the Federal Cotton Dust Standard states that certain prediction equations of African Americans should be reduced by 15% to adjust for ethnic differences. Therefore, in the Patient Information program, if you enter the *Black or African American* category for the *Race* field, this will signal to the software to reduce certain prediction equations by 15% for this patient study. Refer to *Patient Information* in Section Two for more details.

5. To delete a line, highlight it and click on *Delete*. Deleting a line will remove it permanently from the list*, only if that category has never been used before*. If the category has been used before, the program will not allow you to delete it; it will simply make the line inactive.

6. Items that are added to a category list are stored in the currently active database. Items from one or more files can be exported as an .xml file, which can be imported by the code editor on other PLUS/2000 systems via floppy disk, CD-R/w disk, or via a network connection. Conversely, an existing .xml file from another PLUS/2000 system can be imported into the database. Use the Import and Export buttons in the Code Editor to perform these functions.

7. To import a file containing a list from some another PLUS 2000 system, click on *Import*. The program will allow you to search for the desired *.xml* file. When you select the desired file, it will be added to the list on the opening screen of the Code Editor.

8. To export a list to a file, click on *Export*. The program will ask you to name the file, which will be given a *.xml* extension by default. When you do so, a copy of the current list will be contained in this file.

9. For a more detailed explanation of the *Open/Close Study Reasons* categories, refer to the *Opening and Closing Studies* topic in Section Two.

## Interpretation Editor

1. If you want an automatic interpretation for your patient study to display on the Final Report, PLUS 2000 provides the Extended Ellis interpretation program.

2. The Interpretation Editor, which is available from the Windows® Tools menu while you are in the Reports option, allows you modify the decision-making points in the Extended Ellis interpretation program or to create an interpretation program of your own.

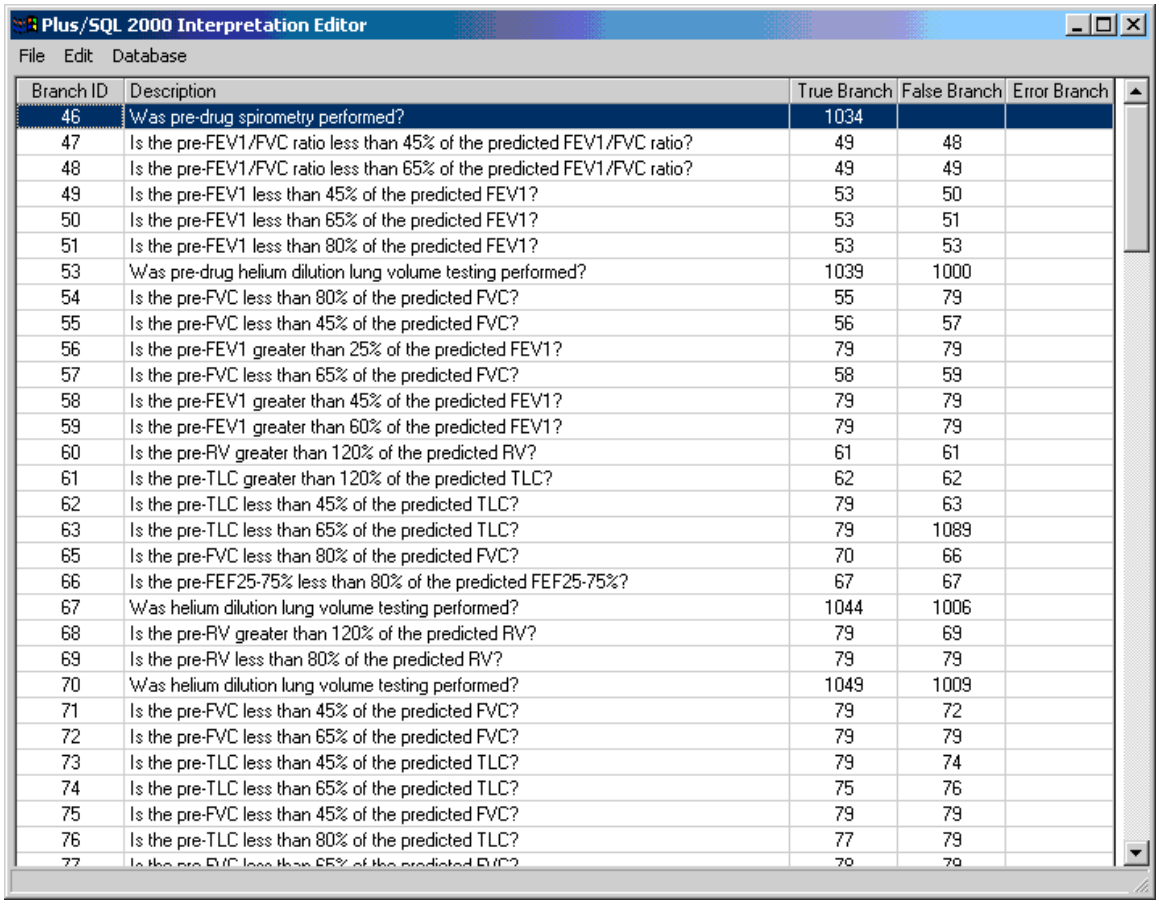
3. To access the Interpretation Editor, from the GO TO menu, select *Reports*. Then from the Windows® *Tools* option, select *Interpretation Editor*.

4. The Extended Ellis Interpretation tree should display. If not, click on File. The following menu will display:

   *New*
   *Open*
   *Save*
   *Exit*

5. Click on *Open*, then on *Extended Ellis*.

6. The program will display the logic of the Extended Ellis Interpretation program in successive interpretive statements. These statements are part of a tree structure in which each line is identified by a Branch ID point. The ID is essentially a line number for that interpretive statement. Each line can contain a True branch point, a False branch point, and/or an Error branch point.




| Branch ID | Description | True Branch | False Branch | Error Branch |
|---|---|---|---|---|
| 46 | Was pre-drug spirometry performed? | 1034 | | |
| 47 | Is the pre-FEV1/FVC ratio less than 45% of the predicted FEV1/FVC ratio? | 49 | 48 | |
| 48 | Is the pre-FEV1/FVC ratio less than 65% of the predicted FEV1/FVC ratio? | 49 | 49 | |
| 49 | Is the pre-FEV1 less than 45% of the predicted FEV1? | 53 | 50 | |
| 50 | Is the pre-FEV1 less than 65% of the predicted FEV1? | 53 | 51 | |
| 51 | Is the pre-FEV1 less than 80% of the predicted FEV1? | 53 | 53 | |
| 53 | Was pre-drug helium dilution lung volume testing performed? | 1039 | 1000 | |
| 54 | Is the pre-FVC less than 80% of the predicted FVC? | 55 | 79 | |
| 55 | Is the pre-FVC less than 45% of the predicted FVC? | 56 | 57 | |
| 56 | Is the pre-FEV1 greater than 25% of the predicted FEV1? | 79 | 79 | |
| 57 | Is the pre-FVC less than 65% of the predicted FVC? | 58 | 59 | |
| 58 | Is the pre-FEV1 greater than 45% of the predicted FEV1? | 79 | 79 | |
| 59 | Is the pre-FEV1 greater than 60% of the predicted FEV1? | 79 | 79 | |
| 60 | Is the pre-RV greater than 120% of the predicted RV? | 61 | 61 | |
| 61 | Is the pre-TLC greater than 120% of the predicted TLC? | 62 | 62 | |
| 62 | Is the pre-TLC less than 45% of the predicted TLC? | 79 | 63 | |
| 63 | Is the pre-TLC less than 65% of the predicted TLC? | 79 | 1089 | |
| 65 | Is the pre-FVC less than 80% of the predicted FVC? | 70 | 66 | |
| 66 | Is the pre-FEF25-75% less than 80% of the predicted FEF25-75%? | 67 | 67 | |
| 67 | Was helium dilution lung volume testing performed? | 1044 | 1006 | |
| 68 | Is the pre-RV greater than 120% of the predicted RV? | 79 | 69 | |
| 69 | Is the pre-RV less than 80% of the predicted RV? | 79 | 79 | |
| 70 | Was helium dilution lung volume testing performed? | 1049 | 1009 | |
| 71 | Is the pre-FVC less than 45% of the predicted FVC? | 79 | 72 | |
| 72 | Is the pre-FVC less than 65% of the predicted FVC? | 79 | 79 | |
| 73 | Is the pre-TLC less than 45% of the predicted TLC? | 79 | 74 | |
| 74 | Is the pre-TLC less than 65% of the predicted TLC? | 75 | 76 | |
| 75 | Is the pre-FVC less than 45% of the predicted FVC? | 79 | 79 | |
| 76 | Is the pre-TLC less than 80% of the predicted TLC? | 77 | 79 | |

Figure 3-27. Sample Interpretation Tree

7. Beginning with the first line, the program will pose its questions for the current patient study and, depending on whether the answer is True or False, proceed to the designated True or False branch line. The Error Branch is reserved for when the program is not able to make an interpretation on a given set of data for any reason. In such a case, it would be incorrect to proceed and thus the program ends in the Error branch.

8. For each line you may enter descriptions that will print depending on whether the answer to that line is True, False, or in Error. These descriptions will be printed out as part of the final interpretation.

9. For example, line 48 in the Extended Ellis program appears as follows:

| | | | | |
|---|---|---|---|---|
| 48 | Is the pre-FEV1/FVC ratio less than 65% of the predicted FEV1/FVC ratio? | 49 | 49 | |

Figure 3-28. Sample Interpretation Editor Line

10. If the patient's current pre-drug FEV1/FVC ratio is less than 65 percent of predicted, then the program will proceed to the True Branch, number 49. At branch number 49, another question will be asked and the program will be referred to another branch. If the value is not less than 65% of predicted, the program will proceed to the False Branch, also number 49, which in return will direct the program to yet another branch.

    Likewise, arriving at line 48 in the tree depended on the program finding the answer to line 47 to be False. If the answer had been true, the program would have skipped 48 and proceeded to 49. In other words, each line in the program is dependent on what information was found for previous lines.

11. Double-clicking on a given line will bring up the Branch Editor dialog, displaying the equation, the English description of the equation, branch point line numbers, and accompanying descriptions for the True, False or Error status of that line.

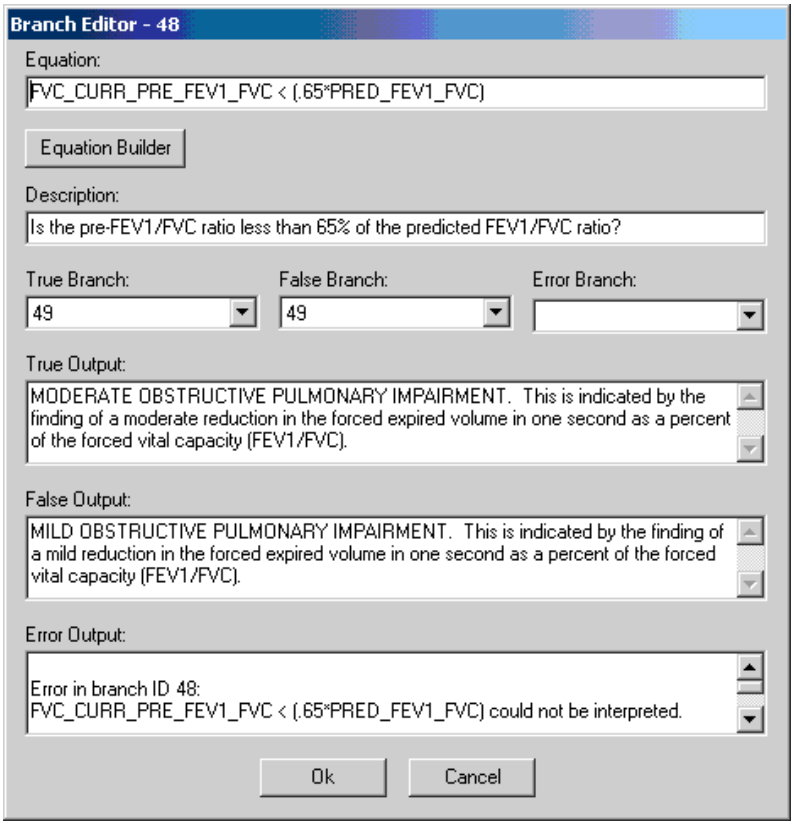

Branch Editor - 48
Equation:
FVC_CURR_PRE_FEV1_FVC < (.65*PRED_FEV1_FVC)
Equation Builder
Description:
Is the pre-FEV1/FVC ratio less than 65% of the predicted FEV1/FVC ratio?
True Branch:
49
False Branch:
49
Error Branch:
True Output:
MODERATE OBSTRUCTIVE PULMONARY IMPAIRMENT. This is indicated by the finding of a moderate reduction in the forced expired volume in one second as a percent of the forced vital capacity (FEV1/FVC).
False Output:
MILD OBSTRUCTIVE PULMONARY IMPAIRMENT. This is indicated by the finding of a mild reduction in the forced expired volume in one second as a percent of the forced vital capacity (FEV1/FVC).
Error Output:
Error in branch ID 48:
FVC_CURR_PRE_FEV1_FVC < (.65*PRED_FEV1_FVC) could not be interpreted.
Ok
Cancel

Figure 3-29. The Interpretation Branch Editor

12. For example, double clicking on line 48 will display the Branch Editor dialog for line 48. Here the text for the True, False, or Error status will display. If the answer to line 48 is true, the program will state *Moderate Obstructive Pulmonary Impairment, etc.* in the *True Output* box and this line will appear in the Final Report Interpretation section. If the answer to line 48 is false, the program will *state Mild Obstructive Pulmonary Impairment, etc*. In either case, the program will proceed to line 49. If an error is found, the program will state that the line could not be interpreted and the program will stop there.

13. The Branch Editor allows you to make changes to the currently selected branch. For example, while in the Branch Editor, click on the *Equation Builder* button for the Extended Ellis line you have selected. This option will allow you to modify or create new equations by selecting test parameters, predicted equation parameters and operations via point-and-click mouse functions. Alternatively, equations can be entered manually and/or edited from the keyboard. As you create the new equation, it will display in the box at the bottom of the equation builder.

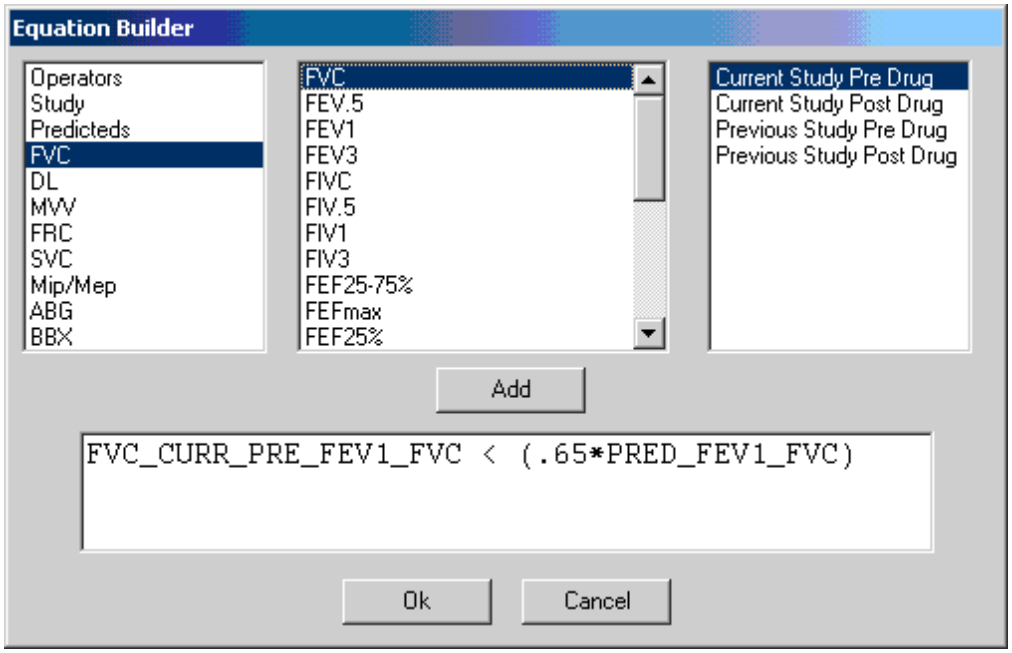



Figure 3-30. Interpretation Equation Builder

14. In the Branch Editor, click on the *Description* text box if you wish to display text on the interpretation branch instead of an equation. Anything entered in Description will override the equation for that line in the tree display. If no text is present in the Description text box, just the logical expression (equation) for that branch ID will be displayed. The Description text option allows you to create an English language description of the test for a branch ID in place of the more cryptic logical expression/equation.

15. You may choose other Branch lines for the True/False/Error descriptions by clicking on their respective down arrows and making another selection.

16. In the True/False/Error Output boxes, you may enter the statements that will accompany the respective True, False or Error findings. Continuing with our example, you may alter the statement under True for line three: *Moderate Obstructive Pulmonary Impairment, etc.*

17. When finished making changes, click on OK to save your changes or Cancel to return to the original set.

18. If you have made changes to the default interpretation tree and wish to return to the original one, click on *Database*, then *Restore Default Database*. The program will ask *Are you sure you want to restore the default Interpretation for PLUS/2000?* Answer *Yes* and the default Extended Ellis tree will be restored.

19. To create an entirely new Interpretation tree, click on *New* from the File menu. The blank Interpretation matrix will display under the headings *Branch ID, Description, True, False, Error*.

20. To insert the first line, click on *Edit*, then *Insert*. A fresh line with the ID number of 1090 will be inserted (since the Extended Ellis tree ends with line 1089). At the same time the Branch Editor dialog will display. Follow the instructions above in order to enter the Equation, Description, True, False, and Error branches, and Output for this line. When done, insert another line (number 1091) and repeat the procedure.

21. Continue to enter new equations and text for as many lines as you need, up to 1000. When finished, click on *File*, then *Save*. The program will ask for the tree name. When you have named your new tree, it will be added to the list of selectable interpretations.

22. The next step is to proceed to the Insert menu in the Reports program. There you will be able to select the interpretation program to be included in the Final Report file you create.

## Trend Configuration

1. Like the Interpretation option, the Trend option is available as a section for the final report. The PLUS/2000 trend report option allows you to plot parameters from up to 50 studies from a single patient ID# for the purpose of observing trending patterns over time. There are two components to the Trend option:

   a. Trend Configuration, described below, allows you to select the start and end dates of the patient whose studies you wish to plot.

   b. The Trend options under Final Report allow you to select the parameters you wish to plot.

2. To access Trend Configuration, from the GO TO menu, select *Reports*. Then from the Windows® Tools option, select *Trend Configuration*.

3. The list of patient IDs will display. Select the patient whose data you wish to plot. Double-click on the desired patient to view his or her studies. This will allow you to select the end-points for the desired period you wish to plot.

4. Make sure the desired patient is highlighted. Then under *Trend Parameters* at the bottom of the dialog, enter the starting and ending dates for the studies you wish to plot.

5. As an example, double-click on *Study 234 - Smith, John* to see the dates of his studies and the tests performed. Let's say he had studies done on the following dates:

   *September 30, 2001*
   *October 25, 2001*
   *January 3, 2002*
   *February 15, 2002*
   *March 8, 2002*

6. If you wished to plot data from all of John Smith's studies, you would enter September 30, 2001 as the starting date and March 8, 2002 as the ending date. If you wanted to plot a shorter time period, you could enter any dates in between these two.

7. When finished entering the Start and End dates, click on *Apply* to finalize your selection. Click on *Close* in order to exit the dialog.

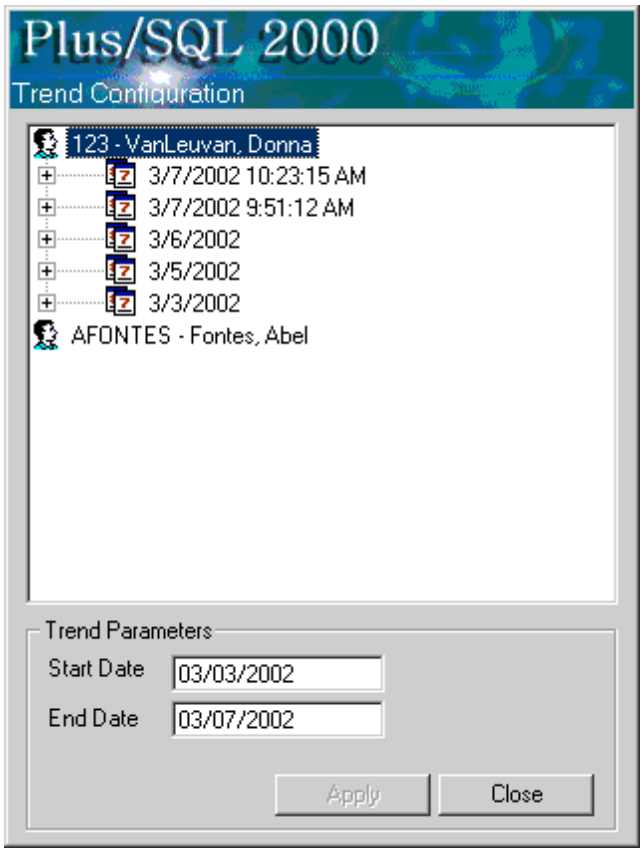



Figure 3-31. Sample Trend Configuration Screen

8. The next step is to proceed to the *Insert* menu under *Reports* in order to create and insert a Trend Section and a Trend Graph section into the desired Final Report file for your patient. In Trend Section and Graph Section you will be able to select the parameters that you wish to plot for your patient. Refer to *Section Seven -- Patient Reports.*

## The PLUS/2000 Language Editor

1. The PLUS language is selected during PLUS/sql 2000 installation and database setup (refer to Section One). The default is US English. PLUS languages may be edited as described in the following steps.

2. All language files, named in accordance with the ISO country code, are stored in a Resources folder located under the C:/Program Files/Collins Medical/PLUS2000 as shown below.

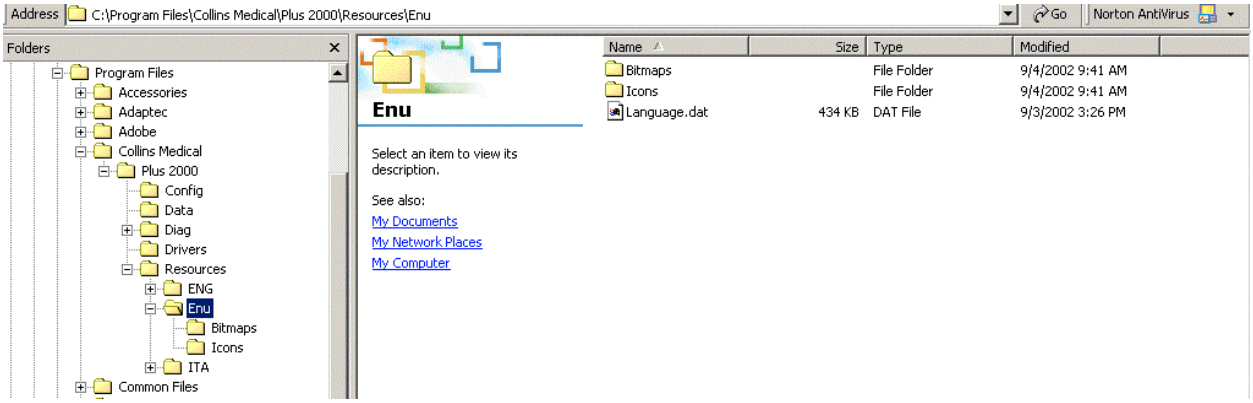



Figure 3-32. Location of PLUS Language Files

- ENG stands for UK English
- Enu stands for American English
- ITA stands for Italian

3. Any one of the language files may be edited by accessing the language.dat file for that particular language.

4. To access the language.dat file, first click on left-click on *Start* and select *Explore*.

5. Double-click on the file, *plustrings.exe*, located in *C:/Program Files/Collins Medical/Plus 2000*.

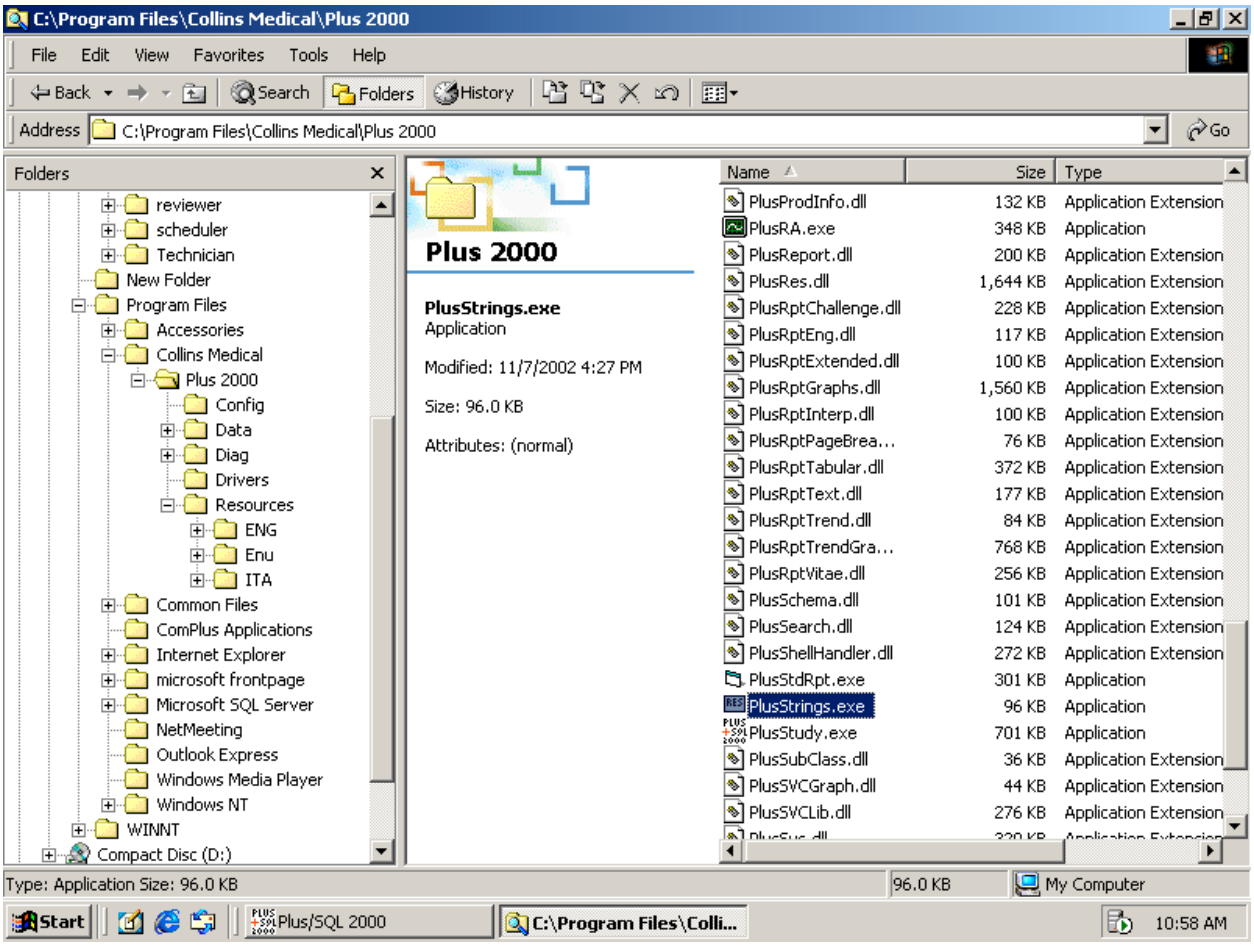



Figure 3-33. Selecting the PlusStings.exe File

6. In the plusstrings.exe program, click on *File*, then *Open*.

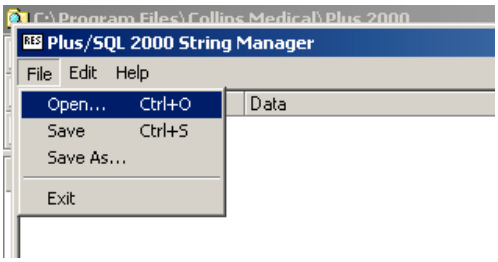



Figure 3-34. Selecting Open from the File Menu

7. Browse to find the language.dat file for the desired language.

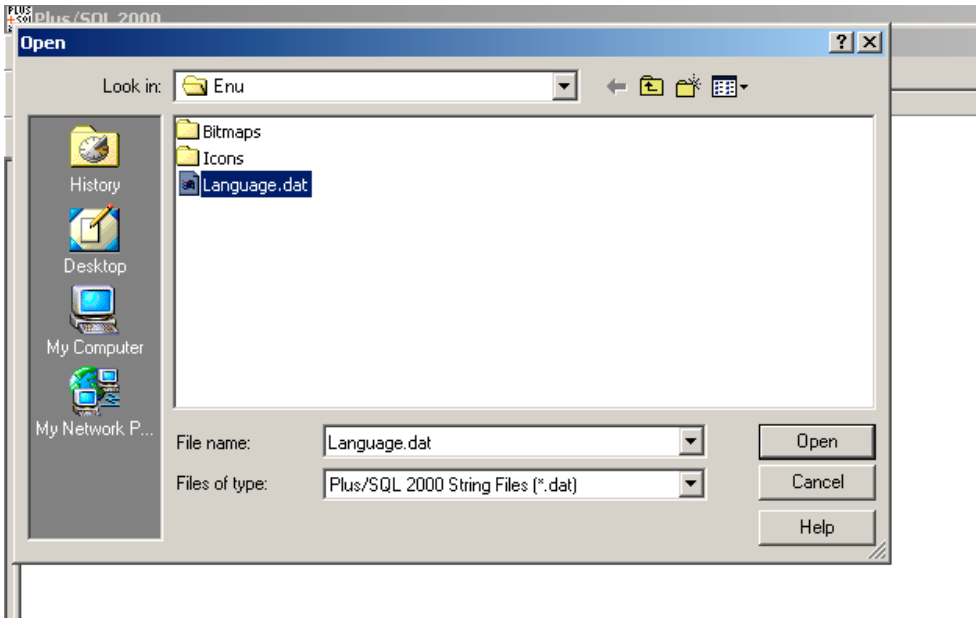



Figure 3-35. Locating the Language.dat File

8. For example, to edit the US English language, click on Enu. Then select the language.dat file.

9. Language.dat is an ASCII editable language file, containing all text strings (labels, messages, etc.) used throughout the PLUS2000 program in a 3-column array. For each text string, the first column contains a numerical ID, the second column contains a variable name, and the third column contains the translated text string that will be displayed by PLUS2k. You may use the *Find* function to locate a desired string.

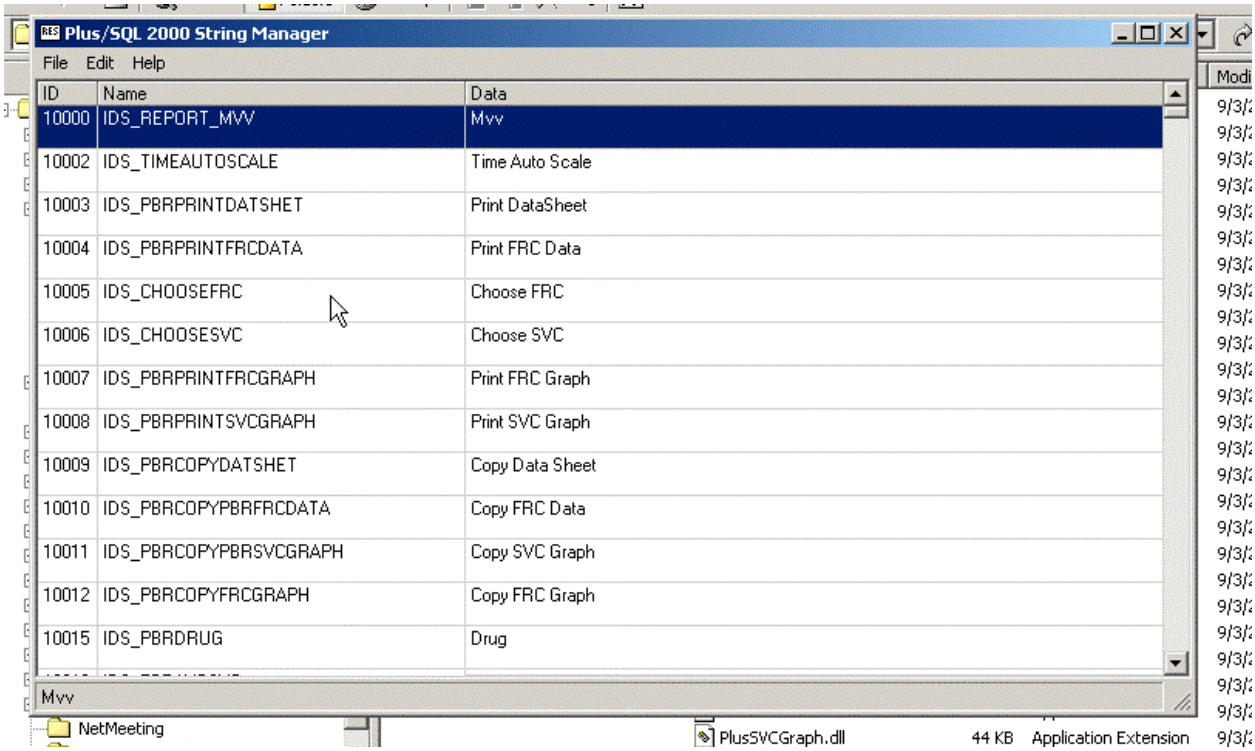



Figure 3-36. The PLUS String Editor

10. To edit a text string, double-click on the desired string in the data column. For example, 10015 reads Drug. You could double-click on *Drug* to change it to *Agent* or *Medication* if you chose to.

11. If you are working in a language other than US English, and a translated string is not present for a given ID, the default US English equivalent string will be displayed.

12. You may translate strings in any of the three language.dat files. Theoretically, you could translate all the strings into another language. For example, you could take the Italian file and translate all the strings into German. However, the name of the file will remain ITA.

**NOTE:**

When you have saved changes to a language.dat file in plustrings.exe, the program will tell you that the language file is newer than the database and ask if you wish to update the database. If you wish to update the database with the changes, answer *Yes*.

# SECTION FOUR -- CALIBRATION

## About Calibration

1. In order to conduct a patient test, a valid calibration file must exist for the type of test you are about to perform. If a valid calibration file does not exist, the program will inform you of this and not allow you to proceed with the test until the calibration has been conducted.

2. General laboratory practice assumes the calibration of all equipment and analyzers on a daily basis as a minimum. Your laboratory may choose to calibrate more or less frequently, depending on your documented experience of the stability of your equipment in your testing environment. PLUS/2000 allows the system Administrator to enforce the frequency at which calibrations are performed by stipulating a date range within which a saved calibration remains valid. When the current calibration exceeds this period, the program will inform the user that the calibration is out of date.

   **NOTE:**
   Because pneumotach calibration is specific to the particular pneumotach in use, calibration must also be conducted whenever a new pneumotach is installed and after the pneumotach has been cleaned.

3. Keep in mind that the currently selected device (selected in Configuration) must be calibrated in order to conduct a test. For the FVC and MVV tests, on the Go To menu bar, to the right of the Pre/Post Rx control, observe which test device is currently selected (*Valve*, *Pneumotach*, or *Spirometer*). If the selected device is *Valve* or *Spirometer*, you must calibrate the spirometer. If using the valve, the spirometer calibration procedure will be semiautomatic. If connected directly to the spirometer, the calibration procedure will require you to lift the spirometer manually, as directed on the screen.

   If the current device is *Pneumotach*, you must calibrate the pneumotach.

4. If the validation period for the most recent calibration has expired, the program will direct you to recalibrate the appropriate subsystem when you initiate the test.

5. In order for calibration results to be as accurate as possible, you must calibrate under the same conditions and with the same equipment as you will be using for testing. For sample, if you will be using a Collins DC-2 filter during testing, use the DC-2 during calibration.

6. To access the calibration program, click on *Tools*, then *Calibration*.

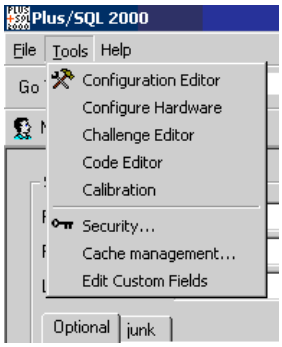



Figure 4-1. The Calibration Option on the Tools Menu

7. The program will display the unopened Calibration Tree with a Legend explaining the tree symbols to the right.

8. At the top of the unopened tree, the devices, or products, connected to your system, such as the CPL or Body Box, will display. Double-click on the *Product*. The program will display your particular system, for example, your CPL with its unique serial number.

9. *USB* and *ISA* are terms that refer to the computer interfaces on the PLUS devices. The enhanced PLUS/2000 Device Manager (USB-DM) will "hot" detect any compatible Collins USB device that is plugged into a USB port of the system

computer and list that device, along with the Product ID and Serial Number, on the Product Calibration dialog as an available USB device. If a USB device is plugged in while at the Product Calibration dialog, press the F5 key to refresh the calibration screen and you will see that device listed. An ISA device displayed on the Product Calibration list will not have a serial number.

10. Double-click on the *Component*, and the transducers comprising that component will display, along with symbols indicating the calibration status for each transducer. These symbols are defined in the Legend to the right. Refer to Figure 4-2.

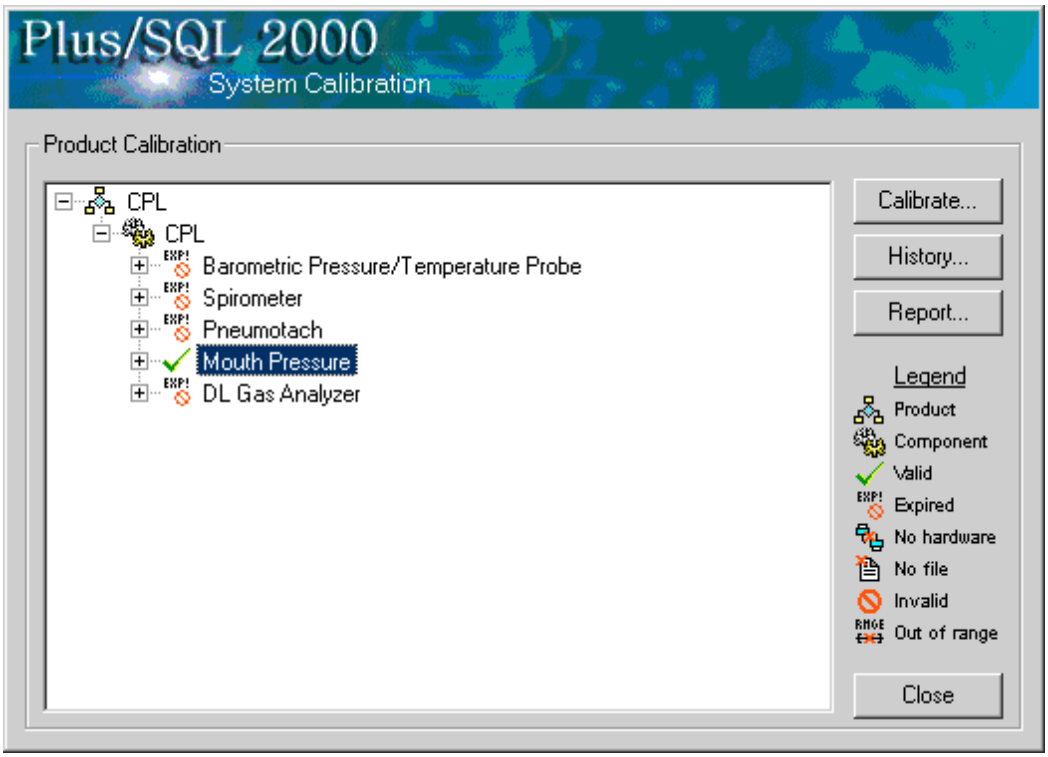



Figure 4-2. System Calibration Tree

11. Following is an explanation of the legend:

**Product:** The type of system you have, such as CPL or Body Box.
**Component:** The particular system you have, identified by a unique serial number.
**Valid:** The Calibration file for this transducer (pneumotach, spirometer, etc.) or a particular calibration parameter is valid.
**Expired:** The Calibration file for this transducer has expired and another calibration must be conducted.
**No Hardware:** The transducer hardware does not exist, is not installed, or is not connected to the system.
**No File:** No calibration has been conducted for this transducer.
**Invalid:** The calibration file for this transducer is invalid for any of a number of reasons
**Out of Range:** The value for a particular calibration value is out of range

12. If a transducer has a green checkmark next to it, then the calibration for that particular transducer is current. If a transducer has a red symbol next to it, such as Invalid, No File, or Expired, then it must be calibrated. Double-click on the transducer for more information.

13. The tree will display the calibration data for the selected transducer, along with a symbol indicating the status of that data. For example, if the value for Pressure Correction under Mouth Pressure were out of range, it would have a red Out-of-Range symbol next to it. If the value is within range and valid, there will be a green checkmark next to it. Refer to Figure 4-2.

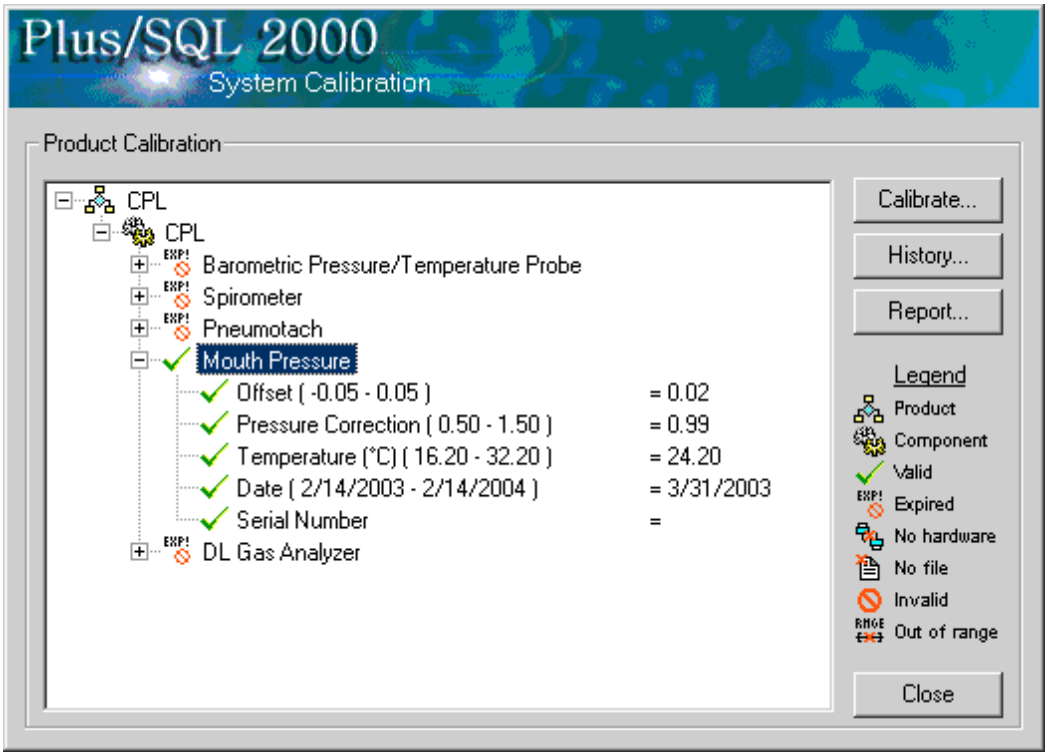



Figure 4-3. Calibration Tree with Transducer Data

14. In order to calibrate a transducer, highlight it and click on the Calibrate button above the Legend. This will take you directly to the calibration procedure. Each procedure is described under its own heading in this Section.

### Barometric Pressure and Room Temperature Calibration

1. In the Calibration Tree, highlight *Barometric Pressure and Temperature Control*, then click on the *Calibrate* button.

2. The program will display the calibration table, with columns for:

   a. the calibration values
   b. the high and low limits of the acceptable range for each value
   c. the status of each parameter after completing the calibration (PASS/FAIL, VALID/INVALID).

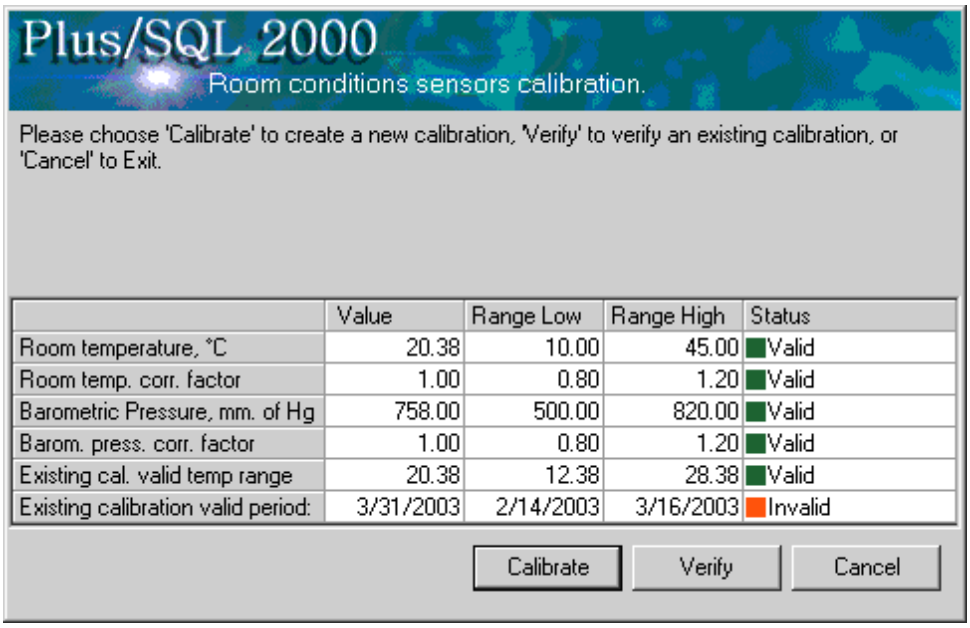



Figure 4-4. Sample Calibration Table

3. The following message will also display:

   *Please choose the Verify Button (V) to switch to verifying the existing calibration, only without saving new values, or the "Calibrate" button (Spacebar) to continue with a new calibration and save the values.*

4. Click on the Calibrate button or press the Spacebar. You will be prompted:

   *Enter the room temperature in Centigrade to the nearest tenth of a degree and then press Enter.*

5. Observe a thermometer in the room near the testing site, enter the temperature as indicated, and press Enter. You will be prompted:

   *Enter the barometric pressure in mmHg and then press Enter:*

6. Observe a barometer in the testing room, enter the barometric pressure, and press Enter.

7. If the calibration is successful, the first 4 parameters in the table will have Pass listed in the status column along with a green box (or whatever Pass color is selected in Configure) and the last two parameters will have Valid listed. The following message will also display:

   *Success: Press the spacebar to replace the existing calibration factors with these new ones or the escape key to retain the existing ones.*

8. If the calibration was not successful, *Fail* will display in the Status column of the out-of-range parameters, along with a red box. The program will instruct you to recalibrate.

9. Follow the same procedure for verifying calibration. The program will inform you if the procedure is successful. If not, repeat the Calibration and Verify procedures until they are successful.

10. When you press the Spacebar to end the calibration, the program returns to the calibration tree.

## Spirometer Calibration

1. If the current testing device is the valve or spirometer, as indicated at the upper right of the screen, the spirometer must be calibrated. The procedure varies somewhat for each of these two configurations.

2. From the calibration tree, highlight Spirometer, then click on the Calibrate button.

**If you are connected to the Balloon Valve:**

1. The program will display the calibration graph and table. The table will contain columns for:

   a. the calibration values
   b. the high and low limits of the acceptable range for each value
   c. the status of each parameter after completing the calibration (PASS/FAIL, VALID/INVALID).

2. At the top of the screen is the message:

   *Please choose the Verify button (V) to switch to verifying the calibration only without saving new values, or the "Calibrate" button (Spacebar) to continue with a new calibration and save the values.*

3. Attach a 3-liter calibration syringe to the valve mouthpiece via a breathing tube. Point and click on the Calibrate button or press the Spacebar. The program will display the message:

   *Please wait while the spirometer is adjusted to its starting volume. Insure that the syringe is completely empty, then press the spacebar.*

4. As instructed, wait while the spirometer automatically rises to the starting volume of 5 liters. If for some reason the spirometer does not rise (such as the source of compressed air not being connected or turned on), the following message will display:

   *Error: The spirometer is not adjusting properly. Check compressed air pressure, tubing, blower, etc. and try again.*

   For more details on the spirometer not rising, refer to the Troubleshooting scenario, *Bell does not rise*.

   When you have corrected the problem, press the spacebar to try again.

5. When the spirometer has stopped rising, make sure that the syringe plunger is pushed in all the way. Then press the spacebar. The program will display the prompt:

   *Slowly fill the syringe completely from the spirometer, then press the spacebar.*

6. As indicated, slowly withdraw the plunger all the way out and press the spacebar. The program then prompts:

   *Slowly empty the syringe completely back into the spirometer and then press the spacebar.*

7. Slowly inject the plunger of the syringe all the way in and then press the spacebar.

8. If the calibration was successful, the following message will display:

   *Success: Press the spacebar to replace the existing calibration factors with these new ones or the Esc key to retain the existing ones.*

9. If the calibration was successful, the values in the table will be filled in and the word Pass or Valid will display in the status column for each value.

10. Green boxes will display next to the word Pass or Valid. The Pass color may be changed in General Configuration.

11. If the resulting calibration is satisfactory, press the spacebar to save results and exit calibration.

12. If the calibration was not successful, the following message will display:

*Failure: One or more of the key values is out of range. Press either the space bar or the escape key to exit. The existing calibration factors are retained. Re-calibration is recommended.*

13. The word *Fail* along with a red* box will display in the status column next to the unacceptable values. (*The Fail color may be changed in *General Configuration*). As indicated, repeat the calibration. For problems with calibration, see *Cal out of Range* in the Troubleshooting section of the CPL manual.

**If you are connected directly to the Spirometer, not using the Balloon Valve:**

1. You will get the same chart shown above with the *Calibrate Verify* and *Cancel* buttons, but the procedure will require manual positioning of the spirometer bell, as described below:

2. Stopper the right breathing port at the base of the CPL with a #6 solid stopper.

3. Connect a breathing tube to the calibration syringe and push the syringe plunger all the way in.

4. Click on Calibrate. The following message will display:

*Please raise the spirometer bell until it reaches 5.0 liters.*

5. Raise the spirometer bell, observing the volume reading in the box on the screen until it says 5.0.

*Start volume reached. Please connect the spirometer, hit space bar to continue.*

6. Still holding the bell at the 5-liter mark, connect the breathing tube and calibration syringe to the left breathing port. Press the spacebar. The prompt displays:

*Insure that the syringe is completely empty and press the space bar.*

7. As instructed, press the space bar.

*Slowly fill the syringe completely from the spirometer and then press the spacebar.*

8. As directed, slowly pull the plunger all the way out and then press the spacebar.

*Slowly empty the syringe completely back into the spirometer and then press the space bar.*

9. Slowly push the plunger in all the way and press the spacebar.

10. You will get the same success or failure messages shown above under Valve calibration. Proceed accordingly.

11. Green boxes will display next to the word *Pass* or *Valid*. The *Pass* color may be changed in *General Configuration.*

12. If the resulting calibration is satisfactory, press the spacebar to save results and exit calibration.

13. If the calibration was not successful, the following message will display:

*Failure: One or more of the key values is out of range. Press either the space bar or the escape key to exit. The existing calibration factors are retained. Re-calibration is recommended.*

14. The word *Fail* along with a red* box will display in the status column next to the unacceptable values. (*The Fail color may have been changed in General Configuration). As indicated, repeat the calibration. For problems with calibration, see *Cal out of Range* in the Troubleshooting section of the CPL manual.

**Verifying Calibration**

1. To verify the calibration, click on the Verify button and repeat the procedure described above. If Verify is successful, the following message will display:

   *Success: Calibration is verified to be within the acceptable range. Press either the space bar or the escape key to exit. The existing calibration values are retained.*

2. If a value is at the limit of an acceptable range, you will still get the *Success* message but a yellow warning box will display next to the marginal value.

3. If the Verify fails, you will receive a message indicating such and directing you to recalibrate.

4. Repeat Calibrate and Verify until they are both successful.

5. When you press the Spacebar to end the calibration, the program returns to the Cal Tree.

## Pneumotach Calibration

**NOTE:**
When using a new MicroTach (the Collins pneumotach) be sure to remove the protective endcaps from each end; otherwise, there will be no flow through the device.

1. If the current testing device is the pneumotach, as indicated at the upper right of the screen, the pneumotach must be calibrated.

2. From the calibration tree, highlight *Pneumotach*, then click on the *Calibrate* button.

3. The program will display the calibration graph and table. The table will contain columns for:

   a. the calibration values
   b. the high and low limits of the acceptable range for each value
   c. the status of each value after completing the calibration (PASS/FAIL, VALID/INVALID).

   The graph is set up for Time in seconds on the *x*-axis versus Volume in liters on the *y*-axis.

4. The following message will display at the top of the screen:

   *Please use the "Verify only" button (V) to switch to verifying the existing calibration only without saving new values, or the (C)alibrate button (Spacebar) to continue with a new calibration and save the values.*

5. Click on the *Calibrate* button or press the spacebar.

   *Insure that there is no flow through the Pneumotach and then press "Continue".*

6. As instructed, make sure there is no flow through the pneumotach and select Continue.

7. An automatic zeroing routine (offset measurement) will take place. During this period, no movement should be introduced in the vicinity of the pneumotach (e.g., no slamming doors, waving breathing tube or moving syringe plunger.) The program prompts:

   *Offset measurement complete. Attach the pneumotach to a 3-liter syringe and then press "Continue".*

   Note that the offset value appears in the table.

8. Attach one end of the breathing tube to the mouthpiece on the patient breathing port of the valve. Attach the other end to the 3-liter syringe. Ensure that the plunger is all the way in. Then click on *Continue*. The program prompts:

   *Press the spacebar and draw 3 liters of air into the syringe within 10 seconds, following the target -2 liters/sec line as closely as possible. Press the space bar again to end.*

   (Note that there is a dotted guideline drawn at -2 liters/sec.)

9. As directed, press the spacebar. A real-time zero flow tracing will begin as soon as you do so. Wait until you see this tracing; then withdraw the syringe plunger all the way, keeping the resulting tracing on or near the line representing -2 L/sec. You must complete the withdrawal within the 10-second time limit shown on the graph. Press the spacebar to end the flow sampling.

Figure 4-5. Example of Zero-Flow Tracing

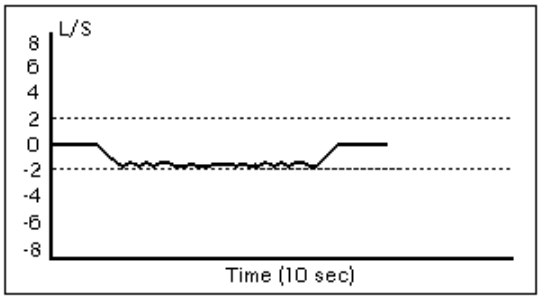



Figure 4-6. Example of an Inspired Flow Calibration Tracing

10. If the maneuver was not acceptable, the program will display an error message and have you repeat the withdrawal phase. Some error messages that may display are:

    *Retry: Average Airflow must exceed 1.*

    *Retry: Peak Airflow may not exceed 4.*

    *Retry: Negative flow produced by withdrawal of air into the syringe is required. Check pneumotach orientation and hookup.*

11. You can avoid the first two messages by trying to keep the flow on the 2 L/sec line. The last message indicates that the direction of flow is reversed from the direction the computer expects for that calibration step.

12. If the maneuver was successful, in the Status column of the table, the program will display the word Pass and a green box for the Offset value and the negative flow correction factor. The program will also display the cal graph, with a dotted line drawn at +2 L/sec, along with the message:

*Press the spacebar and eject 3 liters of air from the syringe within 10 seconds, following the target 2 L/sec line as closely as possible. Press the spacebar again to end.*

13. The syringe plunger will be all the way out from the previous step. As instructed by the program, press the spacebar. When you see the zero flow tracing, inject the syringe plunger all the way, keeping the resulting tracing on or near the line representing 2 L/sec. You must complete the withdrawal within the 10-second time limit shown on the graph. Press the spacebar to end the flow sampling.

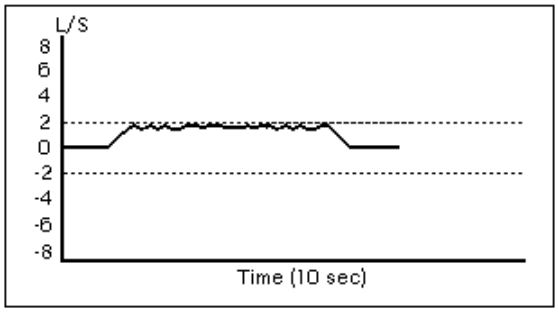



Figure 4-7. Example of an Expired Flow Calibration Tracing

14. If the maneuver was successful, the program will display the positive flow correction factor, along with the word Pass and a green box, in the table. However, if the maneuver was not acceptable, the program will display an error message and have you repeat the injection phase.

15. Also, if the entire maneuver was successful, the program will display the following message:

*Success: Press the spacebar to replace the existing calibration factors with these new ones or the Escape key to retain the existing ones.*

16. Press the spacebar to save the results and exit the calibration program.

**Verifying Flow Calibration**

1. Collins recommends that Verify be performed after each calibration. To verify the saved calibration, click on Verify. Verify may be performed with a syringe of any volume. The Verify procedure will not cause any calibration values to be changed. The Calibrate and Verify procedures are the same except for the following:

   a. During the Verify procedure, the flow cal factors arrived at during the last saved calibration maneuver are used to calculate the volume integrated by the pneumotach.

   b. There are no constraints on flow rate. You may verify calibration by injecting or withdrawing the syringe at any speed between +/-16 L/sec.
   c. We do recommend that you verify the calibration using high, medium and low flows for both expiratory and inspiratory phases and that you check pneumotach symmetry by combining inspiratory and expiratory flow in the same sample sequence. You may also follow the ATS recommendations. For all phases, the volume should be within +/-3% of 3 liters (2.91 - 3.09).

*Recommended Verify Procedure*

1. Following is the Recommended Verify procedure:

   a. Injecting the syringe at high flows, so that the loop reaches a maximum peak of approximately 12 L/sec, checks the range and capability of the pneumotach.

   b. Injecting the syringe at medium flow checks the overall performance of the system.

c. Injecting the syringe at a very slow speed, so that it takes between 7 and 8 seconds to complete, checks the electronics of the system. If values are out of range for this procedure, it may be an indication of instrument baseline drift or the current zero-offset may be invalid (because of flow through pneumotach or movement during zero-offset measurement.)

d. Combining expiratory and inspiratory flow in the same sequence checks pneumotach symmetry. Begin with the syringe plunger fully injected.

e. When the zero flow line starts, perform very shallow strokes with the syringe to simulate light panting. Before ending the maneuver, push the plunger in all the way to return it to its original starting position, or withdraw it completely to effect a volume change equal to the volume of the syringe. Then press the spacebar to end the maneuver. The volume should be within 100 ml of zero (+/-0.10) when the syringe is returned to the original position, or +/-3% of the syringe volume when completely withdrawn.

2. If the results for any phase of the Verify procedure are not within the acceptable ranges as stated above, repeat the verify procedure. If the results are still out of range, perform the calibration procedure again. Then repeat the phases of the verify procedure. If the results are still out of range, refer to Troubleshooting.

3. When you are satisfied with the Verify procedure, press Esc to return to the Cal menu.

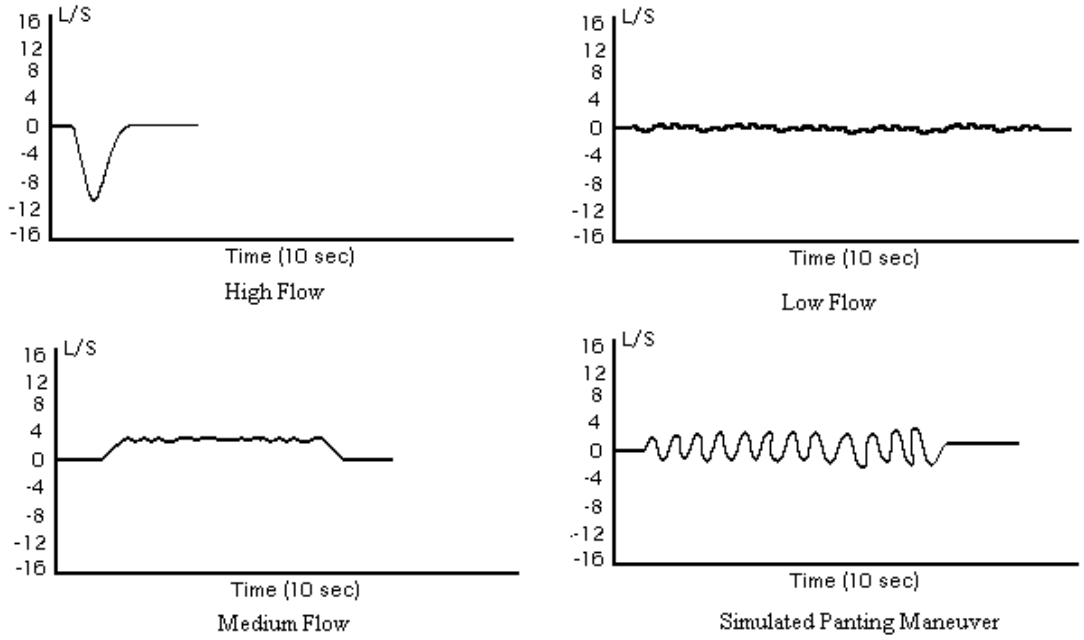



Figure 4-8. Sample Recommended Flow Verify Tracings

## $N_2$ Washout Lung Volumes Calibration

1. In the Collins Eagle, Lung Volumes testing is conducted using the Nitrogen Washout method. The gas analyzers must be calibrated for this test.

2. Turn on the tanks containing the CPX Span gas (15.00% $O_2$, 5.00% $CO_2$, balance $N_2$) and the $O_2$ gas (99% USP).

3. From the calibration tree, click on *Eagle* (or GEM), then *$N_2$ Gas Analyzer*, then on the *Calibrate* button.

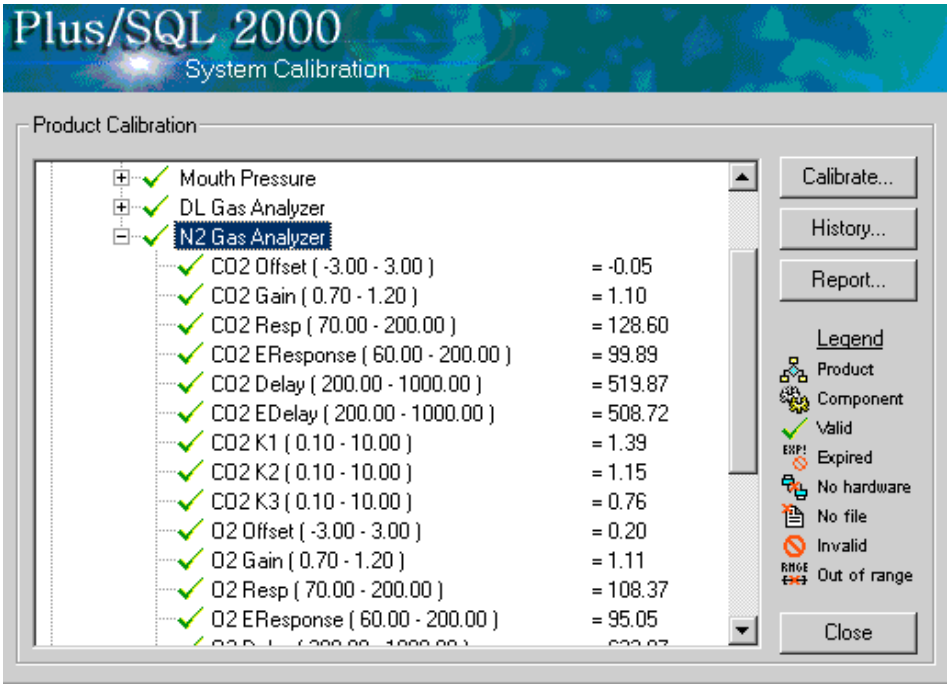
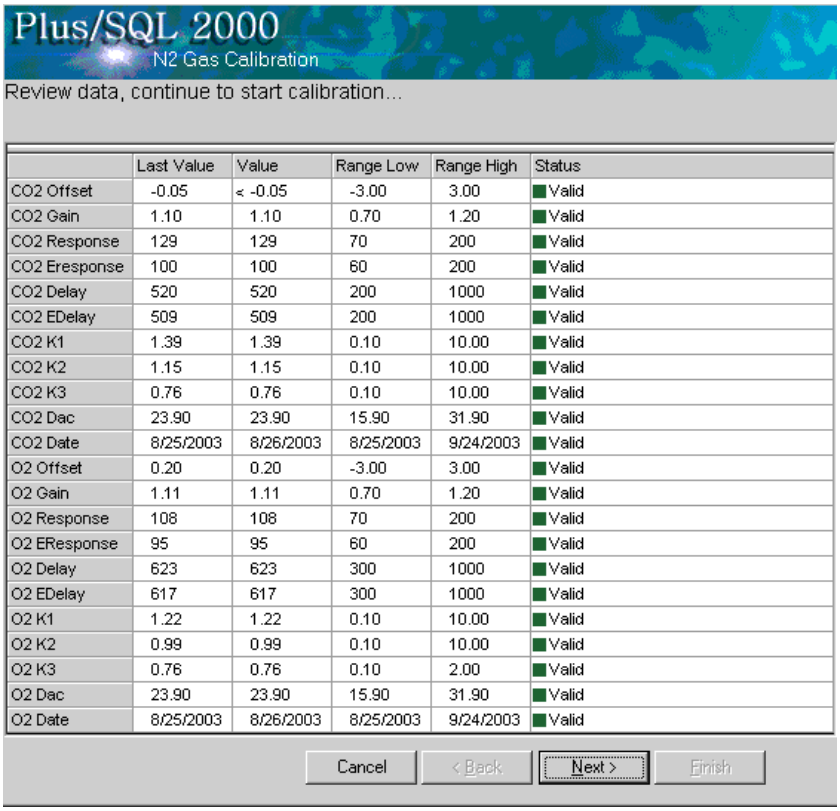

Plus/SQL 2000
System Calibration
Product Calibration
Mouth Pressure
DL Gas Analyzer
N2 Gas Analyzer
CO2 Offset ( -3.00 - 3.00 ) = -0.05
CO2 Gain ( 0.70 - 1.20 ) = 1.10
CO2 Resp ( 70.00 - 200.00 ) = 128.60
CO2 EResponse ( 60.00 - 200.00 ) = 99.89
CO2 Delay ( 200.00 - 1000.00 ) = 519.87
CO2 EDelay ( 200.00 - 1000.00 ) = 508.72
CO2 K1 ( 0.10 - 10.00 ) = 1.39
CO2 K2 ( 0.10 - 10.00 ) = 1.15
CO2 K3 ( 0.10 - 10.00 ) = 0.76
O2 Offset ( -3.00 - 3.00 ) = 0.20
O2 Gain ( 0.70 - 1.20 ) = 1.11
O2 Resp ( 70.00 - 200.00 ) = 108.37
O2 EResponse ( 60.00 - 200.00 ) = 95.05
Calibrate...
History...
Report...
Legend
Product
Component
Valid
Expired
No hardware
No file
Invalid
Out of range
Close

Figure 4-9. The $N_2$ Gas Analyzer Calibration Tree

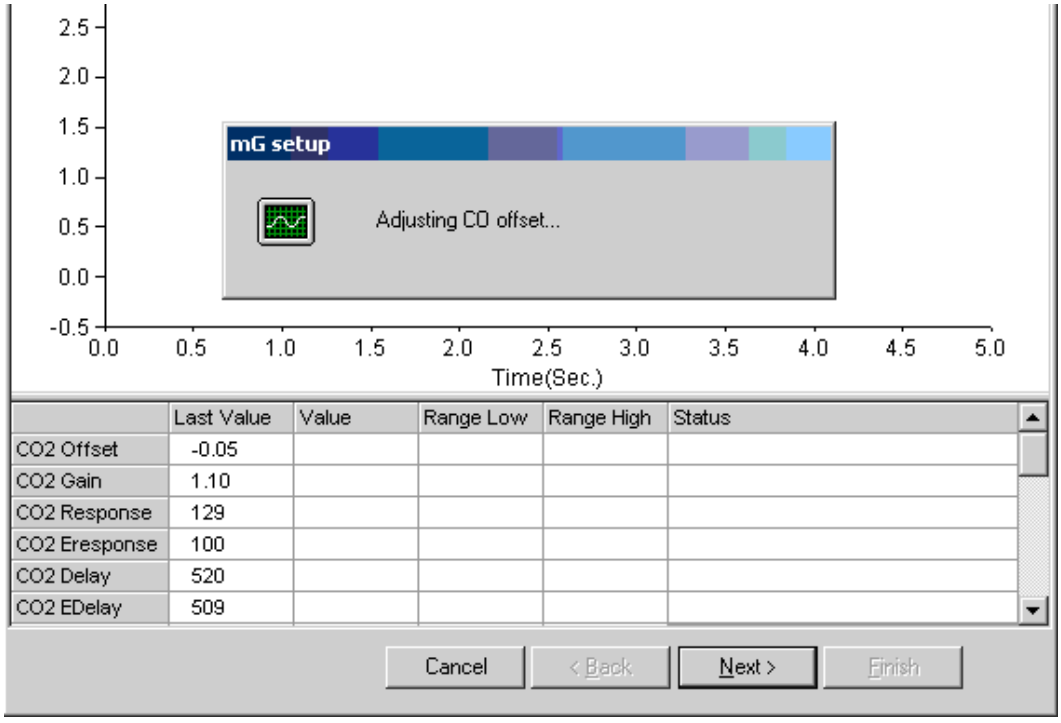
4. The program will display the current calibration data and direct you to click on *Next* to calibrate.




| | Last Value | Value | Range Low | Range High | Status |
|---|---|---|---|---|---|
| CO2 Offset | -0.05 | < -0.05 | -3.00 | 3.00 | Valid |
| CO2 Gain | 1.10 | 1.10 | 0.70 | 1.20 | Valid |
| CO2 Response | 129 | 129 | 70 | 200 | Valid |
| CO2 Eresponse | 100 | 100 | 60 | 200 | Valid |
| CO2 Delay | 520 | 520 | 200 | 1000 | Valid |
| CO2 EDelay | 509 | 509 | 200 | 1000 | Valid |
| CO2 K1 | 1.39 | 1.39 | 0.10 | 10.00 | Valid |
| CO2 K2 | 1.15 | 1.15 | 0.10 | 10.00 | Valid |
| CO2 K3 | 0.76 | 0.76 | 0.10 | 10.00 | Valid |
| CO2 Dac | 23.90 | 23.90 | 15.90 | 31.90 | Valid |
| CO2 Date | 8/25/2003 | 8/26/2003 | 8/25/2003 | 9/24/2003 | Valid |
| O2 Offset | 0.20 | 0.20 | -3.00 | 3.00 | Valid |
| O2 Gain | 1.11 | 1.11 | 0.70 | 1.20 | Valid |
| O2 Response | 108 | 108 | 70 | 200 | Valid |
| O2 EResponse | 95 | 95 | 60 | 200 | Valid |
| O2 Delay | 623 | 623 | 300 | 1000 | Valid |
| O2 EDelay | 617 | 617 | 300 | 1000 | Valid |
| O2 K1 | 1.22 | 1.22 | 0.10 | 10.00 | Valid |
| O2 K2 | 0.99 | 0.99 | 0.10 | 10.00 | Valid |
| O2 K3 | 0.76 | 0.76 | 0.10 | 2.00 | Valid |
| O2 Dac | 23.90 | 23.90 | 15.90 | 31.90 | Valid |
| O2 Date | 8/25/2003 | 8/26/2003 | 8/25/2003 | 9/24/2003 | Valid |

Figure 4-10. $N_2$ Analyzer Calibration Review Data

5. Click on the Next button, when highlighted, to progress through the procedure.




| | Last Value | Value | Range Low | Range High | Status |
|---|---|---|---|---|---|
| CO2 Offset | -0.05 | | | | |
| CO2 Gain | 1.10 | | | | |
| CO2 Response | 129 | | | | |
| CO2 Eresponse | 100 | | | | |
| CO2 Delay | 520 | | | | |
| CO2 EDelay | 509 | | | | |

Figure 4-11. Continuing with $N_2$ Analyzer Calibration

5. If the calibration was successful, the following message will display:

*Calibration has PASSED, continue to save calibration.*

If the calibration was not successful, the program will inform you of such and direct you to recalibrate

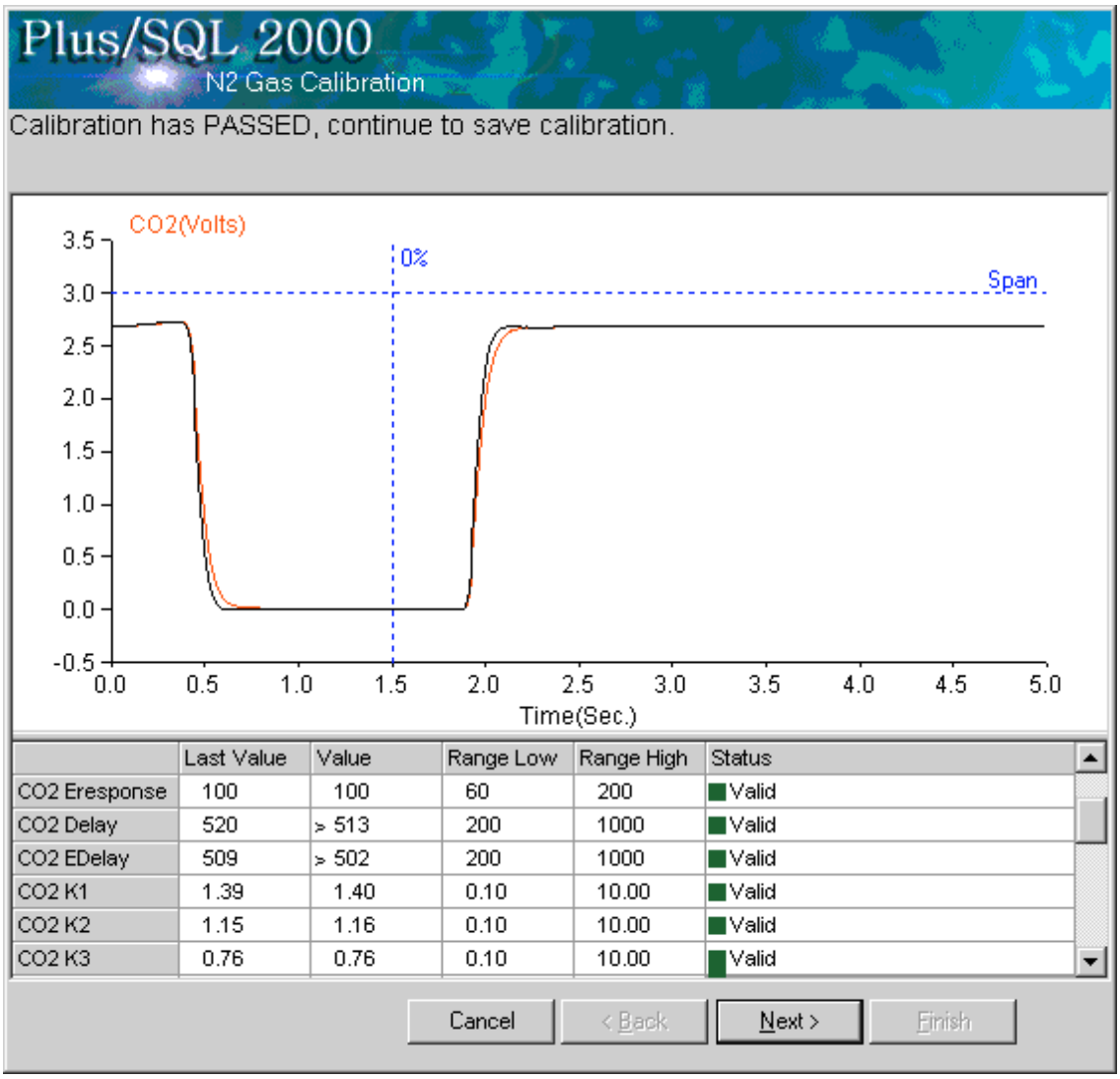



Figure 4-12. Resulting $N_2$ Washout Analyzer Calibration

6. Click *Next* to continue to the next display.

7. Click on *Finish*, and the program will return to the calibration tree, saving the new Cal values.

8. For any problems with analyzer calibration, refer to *Analyzer Cal Problems* in the Troubleshooting section of the Eagle manual.

## Diffusion Calibration

1. For Diffusion Testing, the microGA analyzer must be calibrated. It is recommended that this be done at least once a week and whenever a complete check of analyzer operation is desired.

2. Turn on the tank containing diffusion gas. Make sure the $O_2$ tank for running the balloon valve is on also.

3. From the calibration tree, highlight *Gas Analyzers*, then click on the *Calibrate* button.

4. The program will lead you through the calibration, which is essentially automatic and involves little manual intervention from the user. First a series of messages will display in succession:

   *Initializing the MG Analyzer*
   *Calculating Capture Time*
   *Adjusting CO2 Offset*
   *Adjusting CH4 Offset*
   *Adjusting CO Offset*
   *Checking Stability*

5. After the last message has displayed the program will display the calibration table, along with the message:

   *Review Data, Continue to start calibration.*

6. At the bottom of the table are the following option buttons:

   *Help  Cancel <Back Next> Finish*

   Only the buttons that are currently available are active. Grayed-out buttons are not active and will not respond to mouse clicks.

7. Click on Next or the Spacebar to continue. The program will display:

   *Starting Cal with Flush and Fill*
   *Initializing the Valve*
   *Purging Sample Line*

   ...followed by a series of alternating Flushing and Filling messages to correspond with the spirometer being flushed and filled. The blank cal graph and chart will also display.

8. The following messages will then appear in succession:

   *Averaging DL (CH4, CO) Zero Gas*
   *Performing DL (CH4, CO) Setup*

   The $CH_4$ and CO zero tracings will display on the graph.

   *Purging Sample Line with Span Gas*
   *Performing DL (CH4, CO) Setup for Response Calculation*

   The $CH_4$ and CO span tracings will display on the graph.

   *Averaging DL (CH4, CO) Span Gas*
   *Calibration has Passed, Continue to Save Calibration*

9. The final gas tracing will display, showing the raw response (the raw response is a measure of analyzer response time before any kind of software speed-up algorithm is applied) and the enhanced response (the sped-up response) of the analyzer to $CH_4$. The raw response line is red and the enhanced response line is black.

10. Click on Next to see the same type of tracings depicting the response of the analyzer to CO gas.

11. Clicking on Back will take you back to the $CH_4$ tracing.

12. The table will display the current calibration values for $CH_4$ and CO in the Value column.

**NOTE:**

*Response* is measured by the 10-90% rise time method.
*Delay* refers to the time it takes the gas to travel through the sample gas path the analyzer.
*EResponse* is the mathematically enhanced raw response.

13. Click on the down arrow at the side of the table to view the values for CO. You may compare the current values with the last ones in the Last Value column. The low and high limits of the range for each parameter will display, along with VALID/INVALID in the status column, depending on the success of the calibration. A green box will display next to Valid and a red box next to Invalid, unless you have changed these colors in Configure.

14. If the calibration was successful, the following message will display:

*Calibration has PASSED, continue to save calibration.*

If the calibration was not successful, the program will inform you of such and direct you to recalibrate

15. Click on Finish, and the program will return to the calibration tree, saving the new Cal values.

16. For any problems with analyzer calibration, refer to Analyzer Cal Problems in the Troubleshooting section of the CPL manual.

## Mouth Pressure Calibration

1. The mouth pressure sensor (The mouth pressure sensor is calibrated for MIPS-MEPS testing) requires less frequent calibration than the other CPL instruments because of its stability. The frequency of mouth pressure calibration is left to your laboratory's discretion.

2. To calibrate the mouth pressure sensor, highlight *Mouth Pressure* on the cal tree and click on the *Calibrate* button. The program will display the calibration table. The table will contain columns for:

   a. the calibration values
   b. the high and low limits of the acceptable range for each value
   c. the status of each parameter after completing the calibration (PASS/FAIL, VALID/INVALID).

3. The program will display the following message:

*Please choose the Verify only button (V) to switch to verifying the existing calibration only without saving new values, or the Calibrate button (Spacebar) to continue with a new Calibration and save the values.*

4. In order to calibrate, click on Calibrate or press the spacebar. The following prompt is displayed:

*Insure that nothing is connected to the mouth pressure connection and then press the spacebar.*

5. As instructed, insure that nothing is connected to the mouth pressure port on the rear of the CPL. Then press the spacebar.

6. The computer takes a zero reading and then updates the prompt to read:

*Attach a calibrated manometer to the mouth pressure connection. Inject 10 cm of $H_2O$ pressure and then press the Spacebar.*

7. In order for mouth pressure calibration to be accurate, the top of the manometer water column must be set at zero to start with. Be sure to check the top of the column at eye level. If the column is not set at zero, loosen the thumbscrew at the side of the manometer and slide the ruler until the zero point lines up with the top of the water column. To assure accuracy

when doing so, line up the bottom of the meniscus of the water column with its mirror image in the ruler.

8. Attach the manometer tubing to the mouth pressure port on the CPL. You may have to remove any existing tube from the mouth pressure port in order to do so.

9. Position the stopcock on the manometer tubing so that all ports are open (i.e., so that the arrows line up with the tubing and the outside port).

10. Completely withdraw the plastic syringe provided with the manometer and attach it to the petcock port.

11. Push in on the syringe, injecting enough air to cause the gauge column to rise to the 10-cm mark. Then press the spacebar.

12. If the calibration was successful, the following message will display:

> *Success: Press the spacebar to replace the existing calibration factors with these new ones or the Esc key to retain the existing ones.*

13. Also, if the calibration was successful, the values in the table will be filled in and the word Pass or Valid along with a green box will display in the status column for each value.

14. If the resulting calibration is satisfactory, press the spacebar; otherwise press Esc. The program will return to the cal tree.

15. If for some reason the calibration was not successful, *Fail* along with a red box will appear next to the failed parameters and the following message will display:

> *Failure: One or more of the key values is out of range. Press either the space bar or the escape key to exit. The existing calibration factors are retained. Re-calibration is recommended.*

16. Repeat the calibration until it is successful.

17. To conduct the Verify procedure, click on Verify and conduct the same procedure. If Verify fails, repeat Calibrate and Verify until they are both successful.

18. When you press the Spacebar to end the calibration, the program returns to the cal tree.

## Calibration History

1. The Calibration dialog now has a *History* button that permits trending of selected calibration parameters for all available calibrations on a specified transducer between any two specified dates.

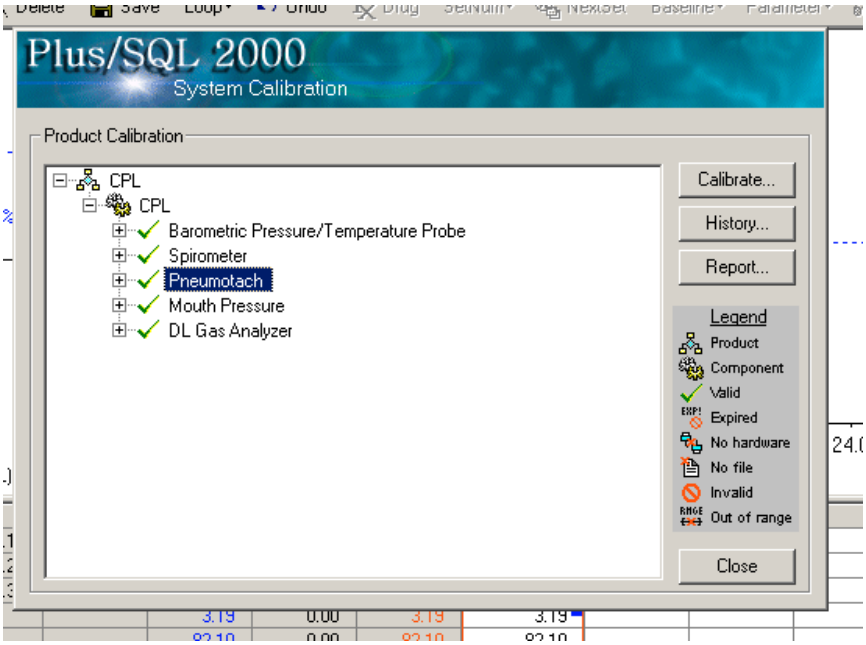



Figure 4-9. Selecting the History Option for the Pneumotach

2. For example, at the Calibration dialog, select the *Pneumotach* as the CPL device. Then click on the *History* button. Enter the start and end dates in the boxes provided. The Calibration data will display in columns headed by each date.

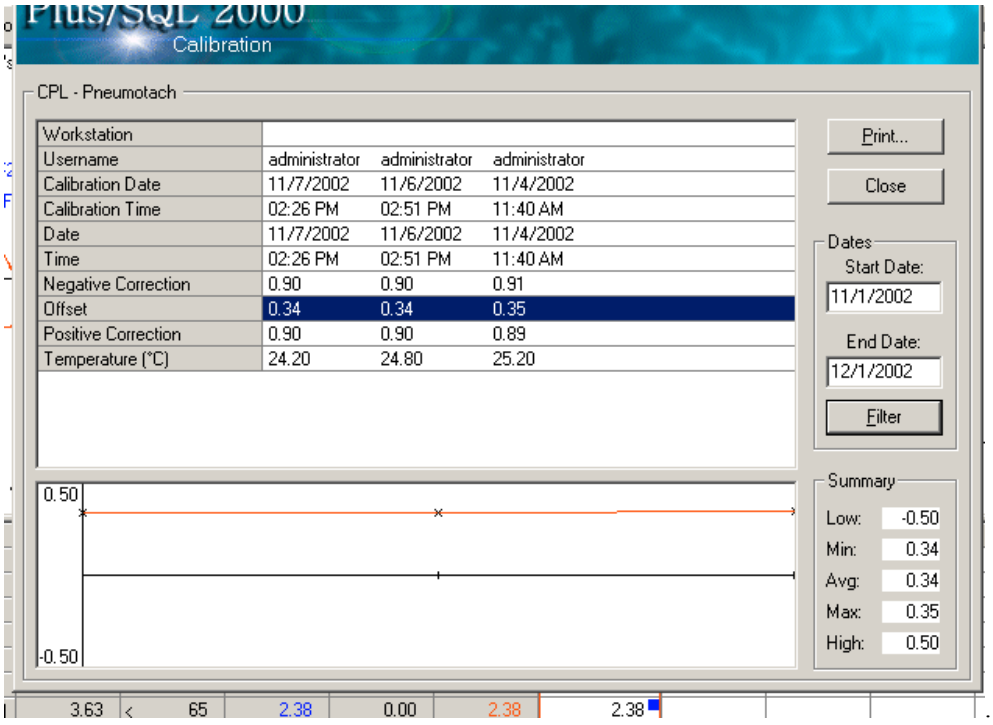



Figure 4-10. Sample Calibration History Data for the Pneumotach

3. If no starting date is entered, the program will present all available calibration data from the beginning of the database to, and including, any calibrations performed on the ending date. If no ending date is specified, the program will display all available calibration data from the start date, through and including the current date. If neither a starting nor an ending date is entered, the program will display all calibration data in the currently selected database.

4. Clicking on a parameter row, such as Offset, will display a trend line for the selected calibration values for that parameter

in a graphic pane located at the bottom of the calibration history dialog. A summary frame to the right of the trend graphic pane will display the upper and lower limits, the minimum and maximum values detected during calibration, and the mean or average for the displayed trend parameter data.

5. When you are reviewing test data, right-clicking on the currently selected test effort will popup a context menu containing a Calibration Data option. Click on this option to view the calibration data in effect for all the system devices at the time that effort was performed.

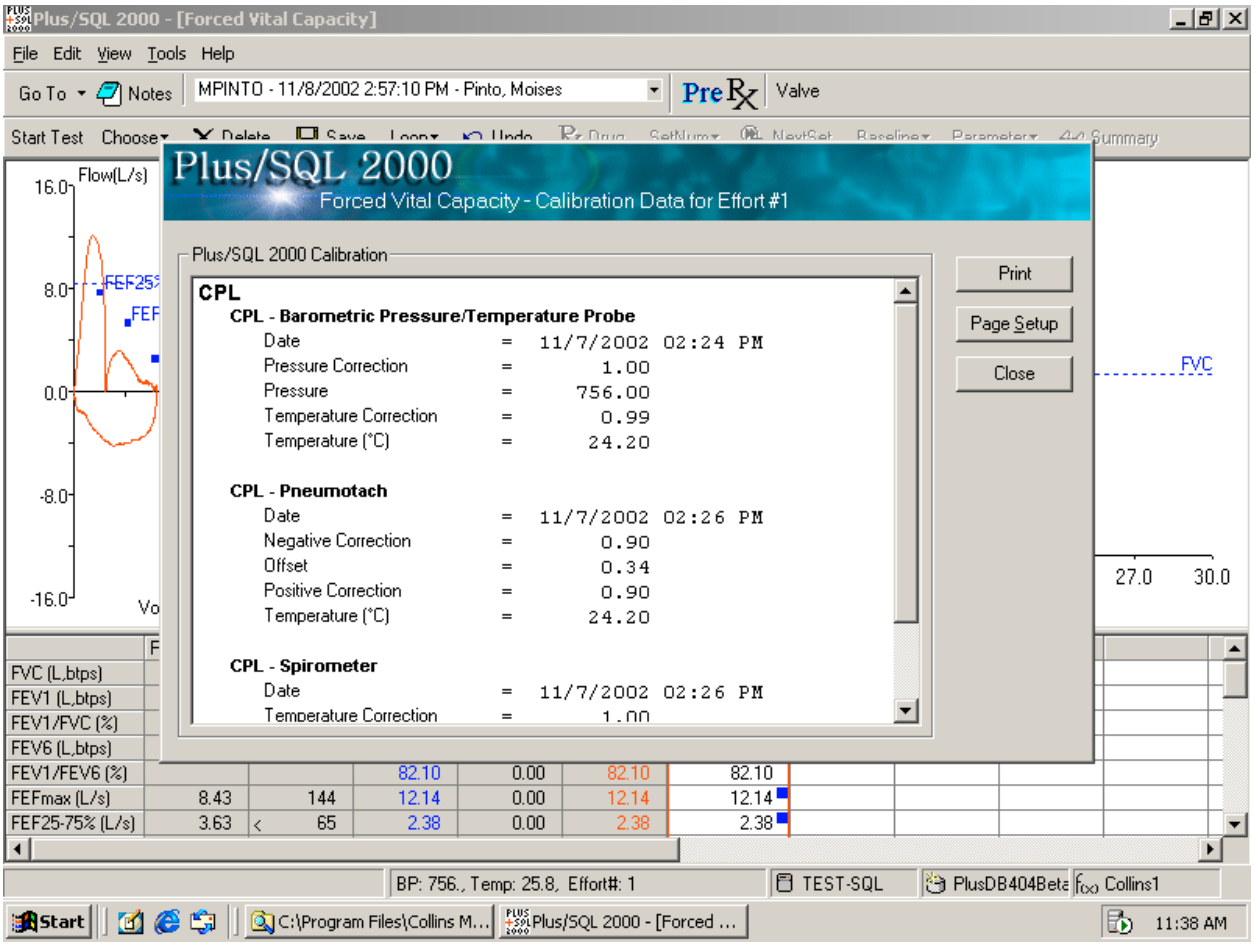



Figure 4-11. Viewing Calibration Data for All Instruments during Test Review

## Calibration Report

1. To set up and print the Calibration Report, from the cal tree, click the *Report* button. The program will display the Calibration Report Generator, as shown below.

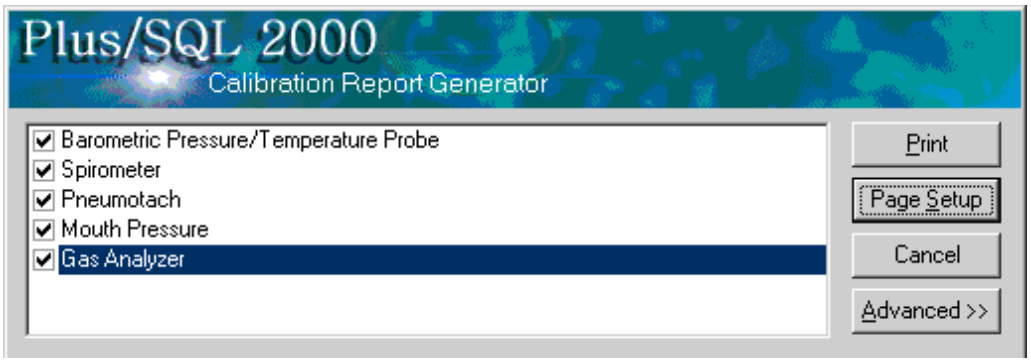



Figure 4-12. Calibration Report Generator

2. The first screen lists all the sections of the Calibration Report. Click on the box next to the ones that you wish to appear on the Report. A check mark will display. Click again on a checked box if you do not want it to display. The check mark will disappear.

   If you had highlighted a particular transducer in the cal tree, just the corresponding section for that transducer will be checked automatically when you enter the Report Generator. If you had highlighted the Component (e.g. CPL) in the cal tree, then all sections would be checked.

3. Before printing the Calibration report, you may wish to configure it. Click on Page Setup. The Page Setup screen will display as shown in below.

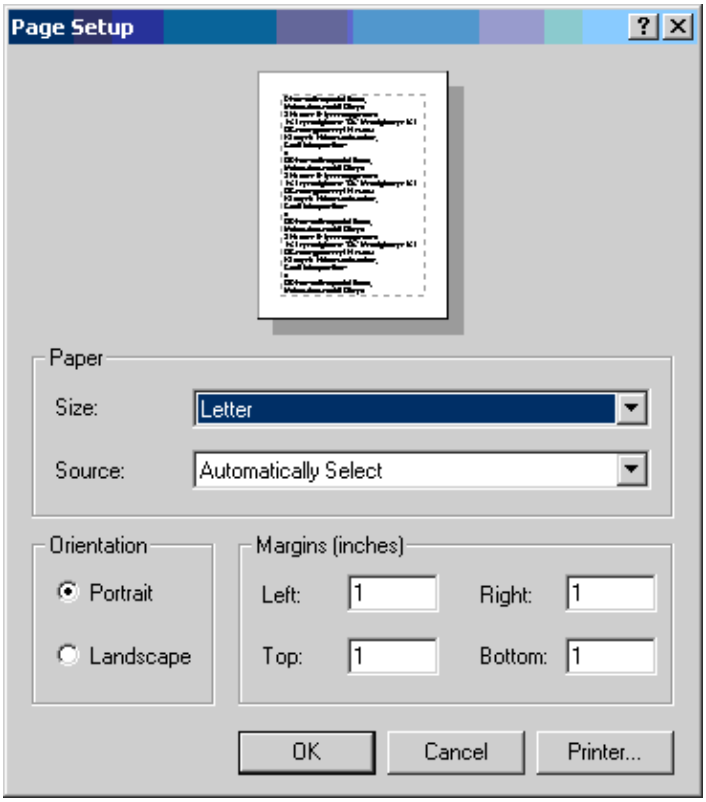



Figure 4-13. Calibration Report Page Setup Screen

4. The Page Setup dialog allows you to select the margins, paper size, source and orientation for your report and operates similarly to any standard Windows® dialog

5. When finished with the Page Setup screen, you may go directly to printing to print the report, or click on *OK* to return to the Calibration Report Generator. There you may click on *Advanced* to get a drop-down window showing more advanced formatting options.

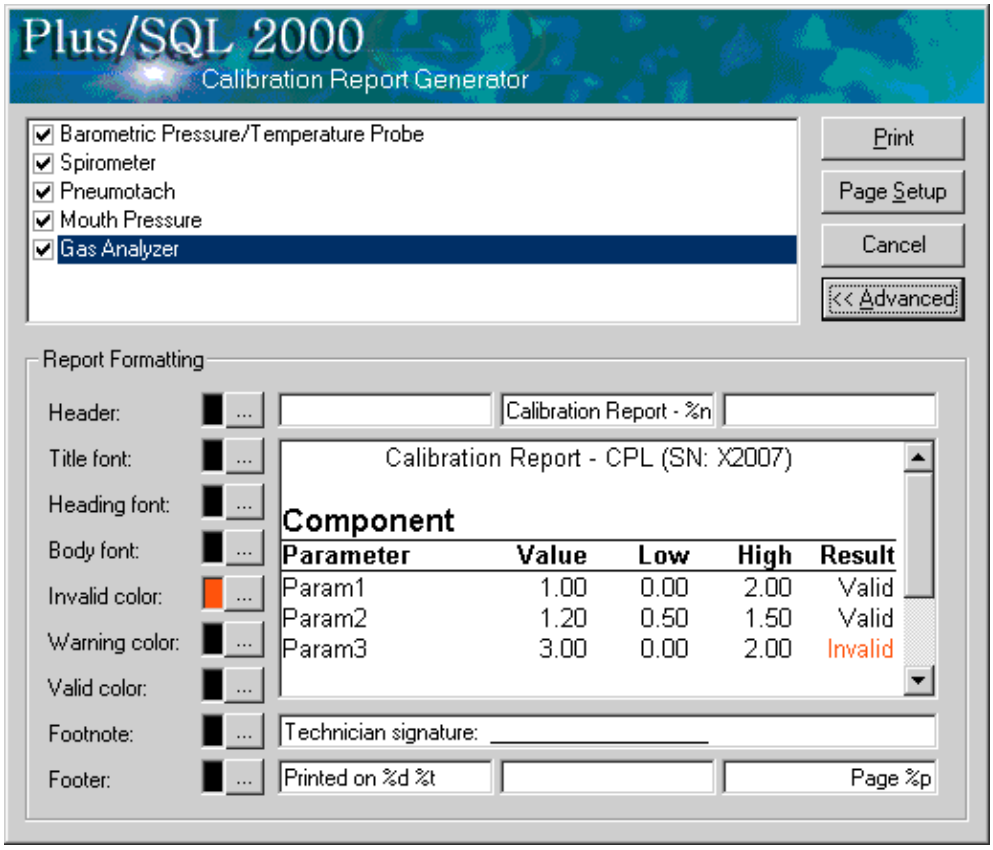



Figure 4-14. Advanced Calibration Report Formatting Options

6. The Advanced Screen displays coloring and font options to the left of a generic sample of the report. The sample allows you to see how the report will appear as you go through and make changes to these options.

7. Click on one of the options to display a dialog for that option. The dialogs are similar to standard Windows® dialogs for color and font. Refer to the samples in Figure 4-15.

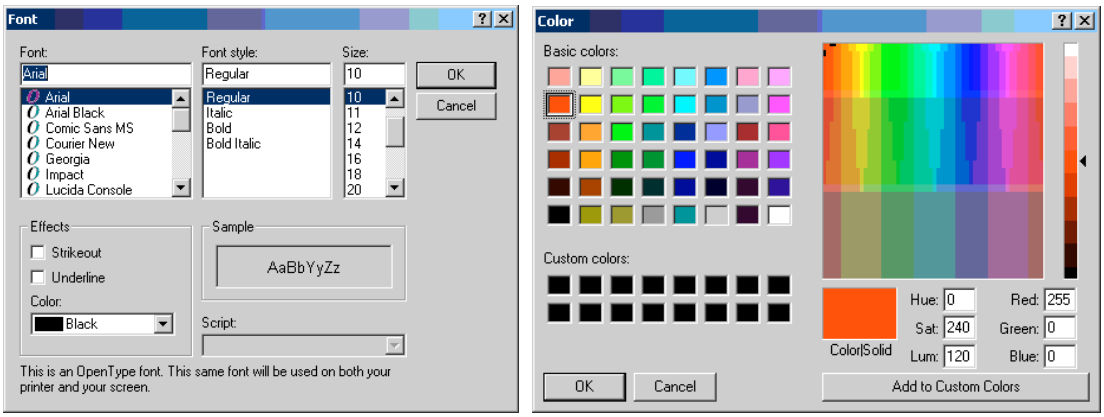



Figure 4-15. Sample Font and Color Option Screens for the Calibration Report Generator

8. The boxes above and below the sample body of the report may be edited to customize the report. Several of these are blank; you may enter whatever you wish into these fields. Several are reserved to automatically print selected information, such as the device and serial number (Calibration Report %n (SN: %s), the time and date (Printed on %d %t) and the page number (Page %p). You may leave these as they are or enter other information. The field for Technician Signature may also be replaced.

9. When finished making changes in the *Advanced* window, you may click on *Print* in order to print the report. A print dialog will display, enabling you to choose from many print options, if desired. When ready to print, click on the *Print* button to produce the report.

# SECTION FIVE -- PATIENT TESTING

## Preliminary Tasks

1. For each test type, 8 efforts can be saved for each pre- and post-drug level. If you wish to conduct more than 8 efforts, you must discard one in order to do another. For FVC challenge tests, 20 levels (sets) may be conducted, with up to eight tests in each set.

2. In order to conduct tests, you must select the desired test device for the test mode you are in. The selected device will display in the GoTo bar to the right of the Pre/Post Rx control. To change the test device, go to the Configure program for that particular test type (located on the Tools button on the Windows® menu bar).

3. The selected devices must be calibrated. Refer to the section in this manual entitled *Calibration*.

4. If you've selected Spirometer in Configure and you're therefore connected directly to the spirometer instead of the valve, certain automatic procedures described herein, such as raising the bell, must be conducted manually.

5. ATS recommends that there be a minimum 4-minute time interval between DSB tests, or following a helium dilution FRC test, when conducted during one study on the same patient, so that any residual helium or carbon monoxide can be fully purged from the patient's breathing system. The program will warn you if the minimum time has not elapsed when you go to perform another test.

   In some individuals it may take much longer to fully expire test gasses. Allow sufficient time, at least as long as the He equilibration time in the FRC test, for your patient to have fully expired test gasses before repeating the DSB or FRC test. Also, it is suggested that the MVV test be performed in between these two tests, as the repeated, forced expirations characteristic of the MVV maneuvers help speed up helium expiration from the patient's lungs.

6. If at any point during testing the program displays the message:

   *ERROR: The spirometer is not adjusting properly.*
   *Check compressed air pressure, tubing, blower, etc. and try again.*

   ...be sure that the appropriate tubing and gas tanks are connected and turned on for the test you are currently conducting. Also, check to see if there is gas in the tank(s). For example, if conducting the FRC test, make sure both breathing tubes are connected correctly to the valve and the CPL, and that the helium and oxygen gas tanks are connected to the system, turned on and have gas in them. Always make sure the $O_2$ tank for operating the valve is on.

7. If you have the optional kymograph, PLUS software will automatically control kymograph speed. The kymograph will automatically start turning when the test is initiated. If you do not desire a kymograph tracing, remove the recording pen tip from the kymograph, observing the precaution below.

   **CAUTION:**
   Since the recording pen holder is weighted, it tends to lean towards the kymograph drum when the pen is removed. During a test, this could cause the kymograph mechanism to jam. Therefore, if you do not desire a kymograph tracing, leave the recording pen in the holder with the cap on and lift it off the kymograph paper.

8. Before you start testing, you must first create a patient study for the desired patient in the Patient Information option or select an appropriate existing study form the PLUS database. (See Section Two on Creating Patient Studies and working with the patient cache.)

9. PLUS software has been designed to allow pre- and post-drug testing for each test type. When a test type is selected, the system defaults to PRE. In order to select Post-drug testing, click on the Pre button at the top right corner of the screen and select Post-drug from the menu.

## About Spirometry

*Spirometry* can be used to refer to all tests that can be conducted with a spirometer. Therefore, the full battery of PFT tests normally conducted on the Collins CPL are often referred to as spirometry: FVC, MVV, Lung Volumes (includes FRC and SVC tests), and DSB. However, simple spirometry refers just to tests that can be conducted with a spirometer alone, that is, FVC, SVC and MVV. In these tests no gasses are involved.

## The Forced Vital Capacity Test

The Forced Vital Capacity (FVC) test is defined as a vital capacity performed with a maximally forced expiratory effort from the point of maximum inspiration; i.e., as hard and fast as possible.

The FVC test may also be conducted on the Collins Body Plethysmograph, if you have this device. Refer to Section Six.

### Preparing Equipment for the FVC Test

1. Refer to *Preparing the System for PFT Testing* in the CPL Hardware Manual for more information about tubing connections between the balloon valve and the CPL, pneumotach connections, etc.

*If Using the Balloon Valve as the Testing Device...*

a. After the basic connections have been made as described in the CPL Hardware manual, attach a DC-2 filter to the patient port on the front of the Balloon Valve. The DC-2 is a low-resistance barrier filter designed for use in preventing patient droplet contamination of pulmonary equipment, thereby preventing patient cross-contamination. The DC-2 filter may be used alone. However, if the patient has a difficult time maintaining a lip seal on the DC-2 opening, a mouthpiece may be attached to the DC-2.

b. Make sure that the tank of $O_2$ for operating the Balloon Valve is connected to the blue inlet on the lower rear panel of the CPL and that it is turned on. To do so, turn the regulator stem counterclockwise with a tank wrench. To turn the tank off, turn the regulator stem clockwise.

c. Attach a noseclip to the patient.

*If Connected Directly to the Spirometer for Testing, and therefore not using the valve...*

Simply keep the tubing attached to the common port (left port on the CPL when facing the unit) and disconnect it from the valve. Insert a fresh disposable mouthpiece or filter into the free end of the tubing. Insert a rubber stopper into the rebreathing port (right port when facing the valve).

*If Using the MicroTach...*

Connect the Patient End (one with the green dot) of the MicroTach to the port opposite the patient port on the Balloon Valve. Attach a DC-2 filter to the patient port on the front of the Balloon Valve. The patient will breathe from the DC-2 filter.

**NOTE:**
When using a new MicroTach, be sure to remove the protective endcaps from each end of the MicroTach; otherwise, there will be no flow through the unit.

### FVC Calibration

If a valid calibration file for *Barometric Pressure/Temperature Probe* and for the *spirometer* (or pneumotach, if *pneumotach* is the currently selected device) are not available, FVC testing cannot be conducted. Perform and save a valid calibration for all instruments involved in the FVC test. Refer to Section Four for details.

**Conducting the FVC (Forced Vital Capacity) Test**

*FVC Test with the Valve*

1. Before conducting the FVC test, make sure the desired patient study is selected as described in Patient Testing. Click on the Pre/Post Rx button to the right of the patient cache to select Pre- or Post-drug testing.

2. To select the FVC test, click on Go To from the Main Menu, followed by FVC. A screen with three panes will display the Flow-Volume loop graph, the Volume-Time graph, the FVC data table and the following prompt line:

   *Start Test / Choose / Delete / Save / Reported / Undo*

3. You may change the size of the panels by pointing to a border and dragging it. For example, to expand the size of the table, point to the top table border and drag it upward. Drag this line downward to enlarge the graphs. You may also use the vertical scrollbar, if present, to scroll through the tabular data.

4. Prepare the equipment for testing according to the setup instructions in Preparing for the FVC Test. If using the valve, be sure to turn on the $O_2$ tank.

5. The first FVC test to be described features full flow/volume loops preceded by tidal breathing. Use of the spirometer/valve will be assumed. If using the pneumotach, refer to FVC Test with pneumotach. If using just the spirometer and not the valve, refer to FVC Test with Spirometer.

6. Select Start Test by clicking on the button or holding down the <Control> key while pressing the <T> key. The following prompt is displayed:

   *Please wait while spirometer is emptied, purged, and filled to its initial volume.*

7. The spirometer bell will rise automatically to 5 liters in order to prevent "bottoming out" or "topping off" during the test. The volume reading will display in a box as it rises. The following prompt is displayed:

   *Insure that the patient is connected to the breathing circuit, press the spacebar to start test.*

8. Explain the procedure to the patient, demonstrating if necessary.

   a. Attach a noseclip.
   b. Connect the patient to the mouthpiece and direct him/her to breathe normally.
   c. Press the spacebar to begin sampling data.

9. The screen displays a real-time tracing of the patient's tidal breathing (if you have configured for tidal breathing) and the kymograph (if present) also begins to record the maneuver. The computer displays the prompt:

   *Press spacebar on inspiration, prior to FVC start (Esc to abort).*

10. When the patient's breathing shows a level tidal volume, direct him/her to inspire maximally to TLC. As soon as the patient begins to inspire, press the spacebar. When the patient has reached TLC, direct him/her to expire maximally and forcefully to RV. Verbally coax the patient during testing to ensure a maximum effort.

    **NOTE:**
    Failure to operate the keyboard as described in the test sequence may lead to invalid test results. You must press the spacebar during the initial inspiration to TLC.

11. When the patient meets the end-of-test criteria according to current ATS recommendations (defined as a volume change of less than 0.030 liters for one second), instruct the patient to take a deep (maximum) breath in.

    The spirometer or pneumotach will continue to collect data until one of the following 3 events occurs:

- 30 seconds have gone by.
- Inspiration is complete; that is, inspiratory flow returns to zero at the end of the maneuver.
- The spacebar is pressed (if manual end-of-test was selected in FVC Configuration).

If the end-of-test criteria has been met, on the Volume-Time graph, a plus sign (+) will display next to EOT at the completion of the test. Otherwise, a minus sign (-) will display.

12. At the completion of each FVC maneuver, three ATS-defined parameters for Effort Quality will display in a line at the top of the Volume-Time graph to indicate the quality of the effort:

    EV - Extrapolated Volume (Refer to this under its own heading in FVC Review)
    EOT - End-of-Test Criteria (volume change less than 30 ml for 1 second)
    TET - Total Expiratory Time. TET - Total Expiratory Time. The ATS states that the total expiratory time for the FVC maneuver should be at least 6 seconds.

    A plus sign next to each of these criteria indicates that the effort with regard to that criteria was satisfactory; a minus indicates that it was unsatisfactory. If all criteria are within limits, the line of parameters will display in green. If one or more of the criteria is out of range, the line will display in red.

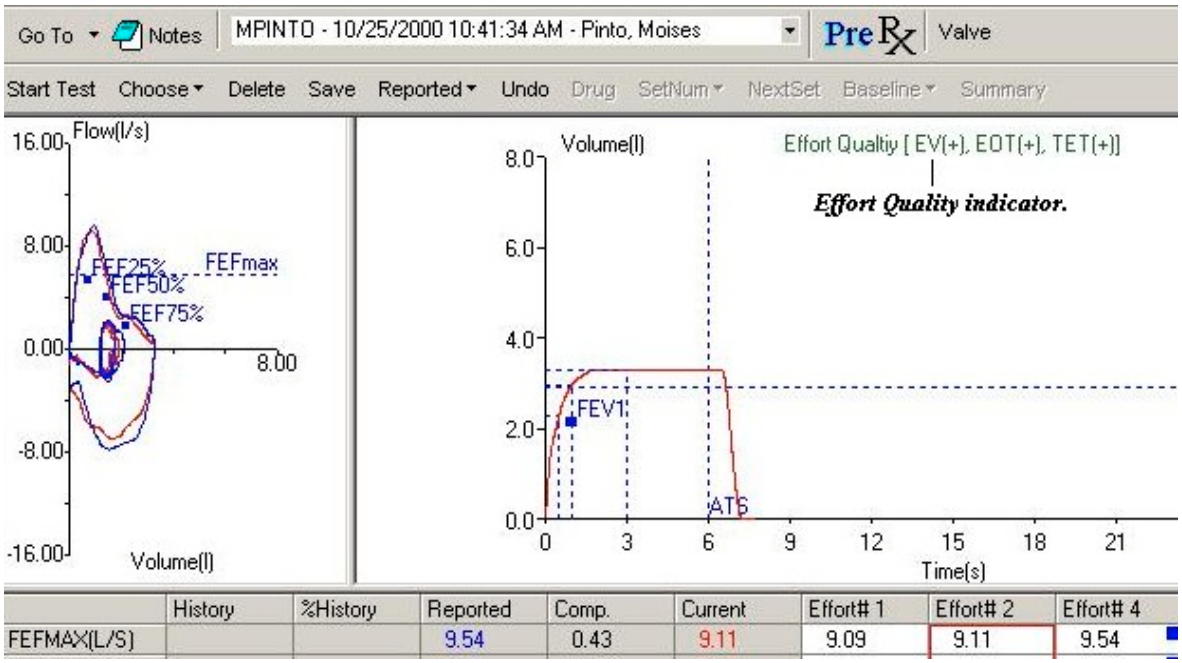



Figure 5-1. A Completed FVC Maneuver

13. Refer to *FVC Review* for an explanation of the resulting data and graphs.

14. Repeat the FVC test until at least three acceptable curves are produced and the largest FVC and second largest FVC do not vary by more than 0.2L and the largest FEV1 and the second largest FEV1 do not vary by more than 0.2 L.

15. You may accept and save up to 8 pre-drug FVC tests per study. The data for the 8 most recently performed tests will display in the chart described above. When you attempt to perform a ninth test, the program will prompt you to discard one effort in order to perform another.

16. You will be prompted to save the FVC data when you exit the test module. If you have not saved the data before exiting, do so by clicking on Save.

**NOTE:**

The graph that will print on the Final Report will be the one that was current when you last saved the data for the FVC test.

*FVC Test with the Pneumotach*

1. Refer to Preparing the Equipment for the FVC Test for directions on how to set up the pneumotach. Be sure you have selected the *Pneumotach* for the testing device in FVC Configuration.

2. The procedure for conducting the FVC with the pneumotach is the same as that for the spirometer/valve, except that the prompts to wait while the spirometer rises to the starting volume are omitted. The program begins with the prompt:

   *Insure that the patient is connected to the breathing circuit,*
   *press the spacebar to start test.*

3. The rest of the procedure is the same.

*FVC Test with Spirometer*

1. To conduct the FVC test while connected directly to the Spirometer instead of the valve, the procedure is basically the same as for Conducting the FVC Test, except that you will be prompted to manually position the bell to the 5-liter starting point.

2. Make sure the system is set up for working directly with the spirometer, as described in Preparing Equipment for FVC Testing. Also be sure you have selected the Spirometer for the testing device in FVC Configuration.

3. The remainder of the test proceeds as described under testing with the balloon valve above.

**FVC Review**

1. At the completion of the test, the following can be observed:

   - The real-time flow/volume loop will be recorded on the screen.
   - The real-time volume-time tracing will be recorded.
   - The Effort Quality line will display in green or red on the Volume-Time graph. If all three criteria have been met (Extrapolated Volume: EV, End-Of-Test: EOT, Total Expiratory Time: TET), this line will display in green. If one or more of the three criteria has not been met, this line will display in red (assumes default colors).

   - The tabular data will display in the datasheet at the bottom of the screen.

2. To delete an effort, click on the effort # heading to make it current. Then select Delete from the prompt line. In order to undelete, select Undo from the prompt line.

3. The Reported effort will be outlined in blue or whatever color you chose in Configure. The reported effort is the one selected from among the available efforts to appear on the Final Report. The PLUS program automatically selects this effort according to the ATS Best Test algorithm, which you may override. Refer to *Reported* under *FVC Datasheet*, below.

4. To save the data, click on Save from the Main FVC menu.

5. Each of the above options is described in detail under its own heading.

*FVC Back Extrapolation*

1. Essentially, back extrapolation determines the true start of expiration in the FVC test. This feature provides accurate determination of all timed volumes (FEV1, FEV3, etc.) in patients who hesitate or lose a little air before the actual forced expiration begins. This situation often occurs in patients who are not familiar with the procedure.

2. The PLUS program follows current ATS recommendations, which state that acceptable efforts must have an extrapolated volume of less than 5% of the FVC or 0.15 L, whichever is greater. If the extrapolated volume is within acceptable limits, you will see a plus sign (+) next to the EV (extrapolated volume) in the Effort Quality Indicator. Otherwise, the program will display a minus sign (-) next to the EV.

*The FVC Datasheet*

1. The FVC tabular data is listed in the bottom pane of the 3-part FVC screen. You may scroll this screen up and down and from side to side to view more of it than fits in the window. The row headings are for FVC test parameters. The column headings are identified by effort and by other categories described below.

**Predicted or History:** Depending on what was selected in FVC Configuration or FVC options, this column will contain the patient's history or predicted values. This gives the user a basis for comparing the Reported, or Best, test results. Predicted refers to the patient's predicted, or normal values; History refers to the selected best effort from the most recent previous study conducted on the patient. (These options may also be selected from the right-click context menu.)

**% Predicted or % History:** Depending on which is selected,, this column will contain either % Predicted or % History results. For each parameter, the % column shows what percentage of the predicted or history value the Reported (best) value represents. For example, if the Predicted FVC is 4.00 liters and the Reported is 3.20 Liters, the %Predicted column would display 80%.

**Effort # Columns:** These columns contain the results of the numerically labeled efforts. If one of these efforts is currently selected, it will also display in the Current Column. If one of these efforts is the Best effort, it will also display in the Reported column. However, note that depending on the best-test criteria selected, not all parameters in the Reported column may come from the same effort.

**NOTE:**
Effort numbers are continued from the previous effort number, even if that effort was deleted. Thus, if you delete Efforts number 1 and 2, the next effort will still be numbered 3 and will not start over again from 1.

If you cannot see all the efforts on the screen at once, use the scroll bar or the arrow keys to bring them into the window.

**Current:** This column contains the effort that is currently selected and highlighted. Click on the desired effort column heading to make it current or select Choose from the Main FVC option line. The Current column is highlighted by red or by whatever color you chose in Configure.

**Reported:** The Reported effort will be outlined in blue or whatever color you chose in Configure. The reported effort is the one selected from among the available efforts to appear on the Final Report. The PLUS program automatically selects this effort according to the ATS Best Test algorithm. This algorithm reports the highest FVC and the highest FEV1, even if they may be from different efforts, and reports the rest of the parameters from the effort with the highest sum of FVC and FEV1. You may override the ATS selection by right-clicking on Reported. The following menu will display:

*ATS*
*FVC*
*FEV1*
*Loop*

If you want the reported effort (automatically selected according to the ATS algorithm) to contain the FVC from another effort, select that effort to make it current. Then click on the Reported Menu option, *FVC (or select FVC from the right-click context menu)*. You will notice that the newly selected FVC will replace the one already in the Reported column.

To select the best FEV1 from another effort, select that effort. Then select *FEV1* from the Reported Menu *(or from the right-click context menu)*. The newly selected FEV1 will replace the one in the Reported Column.

If you want the reported effort to contain all of the data, except FVC and FEV1, from another effort, select that other effort, then click on *Loop*. In the Reported Column, you will see all of the data except FVC and FEV1 replaced by those of the new effort.

If you decide that you wish to revert to the ATS selection criteria, select *ATS*.

Since not all Reported data will necessarily come from the same effort, in the actual effort columns, a value will have a blue box next to it if it is part of the Reported effort.

The Reported override menu is also available by placing the mouse cursor anywhere on the tabular data area and right-clicking.

**NOTE:**

The graph that will print on the Final Report will be the one that was current when you last saved the data for the FVC test.

**Comp. (Comparison):** This column contains the numeric differences between the parameters in the Current and in the Reported column, for comparison. Note that the values will be zero if values from the Current column are also in the Reported column.

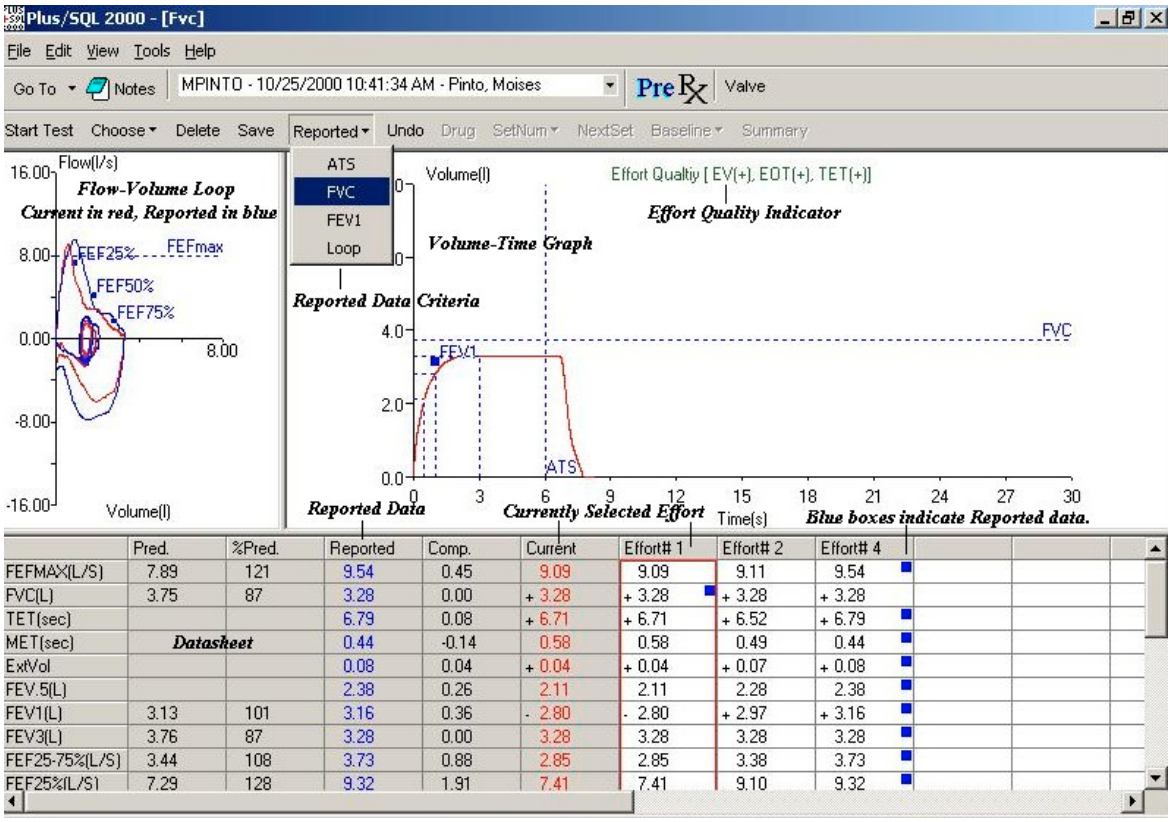

Plus/SQL 2000 - [Fvc]
File Edit View Tools Help
Go To Notes
MPINTO - 10/25/2000 10:41:34 AM - Pinto, Moises
Pre Rx
Valve
Start Test Choose Delete Save Reported Undo Drug SetNum NextSet Baseline Summary
ATS
FVC
FEV1
Loop
Reported Data Criteria
Flow(l/s)
Flow-Volume Loop
Current in red, Reported in blue
FEF25%
FEFmax
FEF50%
FEF75%
Volume(l)
Volume-Time Graph
Effort Qualtiy [ EV(+), EOT(+), TET(+)]
Effort Quality Indicator
FVC
FEV1
ATS
Time(s)
Reported Data
Currently Selected Effort
Blue boxes indicate Reported data.
Pred. %Pred. Reported Comp. Current Effort# 1 Effort# 2 Effort# 4
FEFMAX(L/S) 7.89 121 9.54 0.45 9.09 9.09 9.11 9.54
FVC(L) 3.75 87 3.28 0.00 + 3.28 + 3.28 + 3.28 + 3.28
TET(sec) 6.79 0.08 + 6.71 + 6.71 + 6.52 + 6.79
MET(sec) Datasheet 0.44 -0.14 0.58 0.58 0.49 0.44
ExtVol 0.08 0.04 + 0.04 + 0.04 + 0.07 + 0.08
FEV.5(L) 2.38 0.26 2.11 2.11 2.28 2.38
FEV1(L) 3.13 101 3.16 0.36 - 2.80 - 2.80 + 2.97 + 3.16
FEV3(L) 3.76 87 3.28 0.00 3.28 3.28 3.28 3.28
FEF25-75%(L/S) 3.44 108 3.73 0.88 2.85 2.85 3.38 3.73
FEF25%(L/S) 7.29 128 9.32 1.91 7.41 7.41 9.10 9.32

Figure 5-2. Menu of Reported Effort Options

2. The key parameters for indicating reproducibility are marked with a plus (+) or a minus (-) sign. Those with a plus sign are within the acceptable range for reproducibility; those with a minus sign are outside the range for reproducibility. The criterion for reproducibility is that each of these parameters be within 0.2 liters of the best parameter in this study.

*Discarding an FVC Effort*

1. The program allows you to save 8 FVC efforts per study. When you have saved 9, the program displays the following message:

*Maximum number of test efforts are exceeded.*
*Must delete an effort to test.*

2. To discard an effort, select the effort as current by clicking on the Effort # header; then click on Delete. Only the currently selected effort can be deleted.

*Undo Command*

To restore an FVC effort just deleted, click on Undo. Note that there must be no other functions performed between the Delete and the Undo command in order for Undo to work.

*FVC Volume-Time Graph*

1. On the FVC Volume-Time graph, a dotted vertical line will display at the ATS recommended 6-second minimum expiratory time. Another dotted line will display at the target FVC, which is based on either the patient's history or predicted values. A box will display at the target FEV1 point.

2. When you have completed the test, the real-time tracing will display in red, with dotted lines drawn to mark other timed volumes (FEV.5 and FEV3).

3. Refer also to the Disability Graph, another type of Volume-Time graph.

*FVC Flow-Volume Loop*

1. When you have completed the FVC test, the real-time flow/volume loop will be recorded on the screen in the upper left-hand pane.

2. Appearing on the graph are boxes representing the patient's predicted values for FEF 25%, 50%, 75%, and FVC, if these predicted values exist in the currently selected predicted set. Also, a dotted line representing the target FEFmax will display.

3. When you have completed more than one effort, the program will designate one of them as being the Reported effort. The data for this effort will display in blue in the Reported column in the datasheet pane. The corresponding loop will display on the Flow-Volume graph in Blue. Note that if you change the Reported Effort criteria (refer to *The FVC Datasheet* under *Reported*, above), a new effort will be highlighted in blue and the corresponding new loop will display on the graph in blue.

4. Likewise, the currently selected effort will display in red on the datasheet pane and the corresponding loop will be displayed on the graph in red. Note that when you change the current effort, the new effort will be highlighted in red and the corresponding new loop will display on the graph in red.

5. The red and blue tracings will be overlaid on the Flow-Volume loop for comparison.

6. If the Reported and the Current efforts are one and the same, a single red tracing will display.

7. If you select the History option via the right click menu, the history loop will be superimposed in black over the other loops (current and best) on the Flow Volume Graph.

8. You may also select History to view the history loop alone before conducting tests.

**NOTE:**
The graph that will print on the Final Report will be the one that was current when you last saved the data for the FVC test.

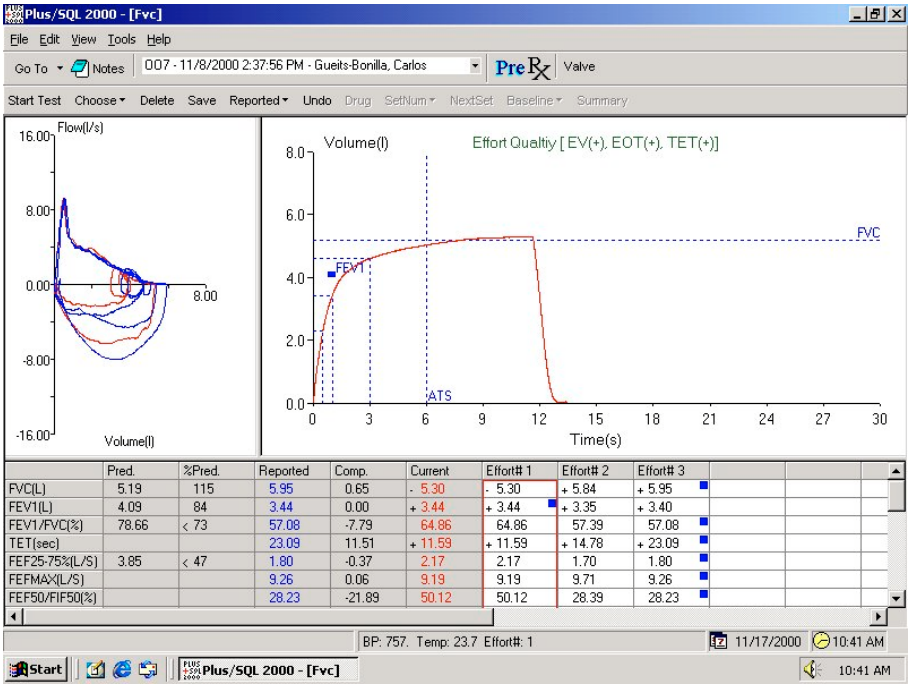

Plus/SQL 2000 - [Fvc]
File Edit View Tools Help
Go To Notes
007 - 11/8/2000 2:37:56 PM - Gueits-Bonilla, Carlos
Pre Rx Valve
Start Test Choose Delete Save Reported Undo Drug SetNum NextSet Baseline Summary
Flow(l/s)
Volume(l)
Effort Qualtiy [ EV(+), EOT(+), TET(+)]
FVC
FEV1
ATS
Time(s)
Pred. %Pred. Reported Comp. Current Effort# 1 Effort# 2 Effort# 3
FVC(L) 5.19 115 5.95 0.65 - 5.30 - 5.30 + 5.84 + 5.95
FEV1(L) 4.09 84 3.44 0.00 + 3.44 + 3.44 + 3.35 + 3.40
FEV1/FVC(%) 78.66 < 73 57.08 -7.79 64.86 64.86 57.39 57.08
TET(sec) 23.09 11.51 + 11.59 + 11.59 + 14.78 + 23.09
FEF25-75%(L/S) 3.85 < 47 1.80 -0.37 2.17 2.17 1.70 1.80
FEFMAX(L/S) 9.26 0.06 9.19 9.19 9.71 9.26
FEF50/FIF50(%) 28.23 -21.89 50.12 50.12 28.39 28.23
BP: 757. Temp: 23.7 Effort#: 1
11/17/2000 10:41 AM
Start Plus/SQL 2000 - [Fvc]
10:41 AM

Figure 5-3. Flow-Volume Loops Overlaid

*FVC Disability Graph*

The Disability Graph is a version of the FVC Volume-Time graph. It provides a smaller scale with more detail, which is acceptable for Social Security Disability evaluation and which satisfies ATS recommendations for conducting hand calculations. When you right-click on the Volume-Time graph, you have the option to change to the Disability graph and vice-versa. See FVC Options.

**NOTE:**

On the Disability graph, all available volume/time tracings can be overlaid as required for disability submission. Overlaying of volume/time tracings on non-disability graphs is not presently supported.

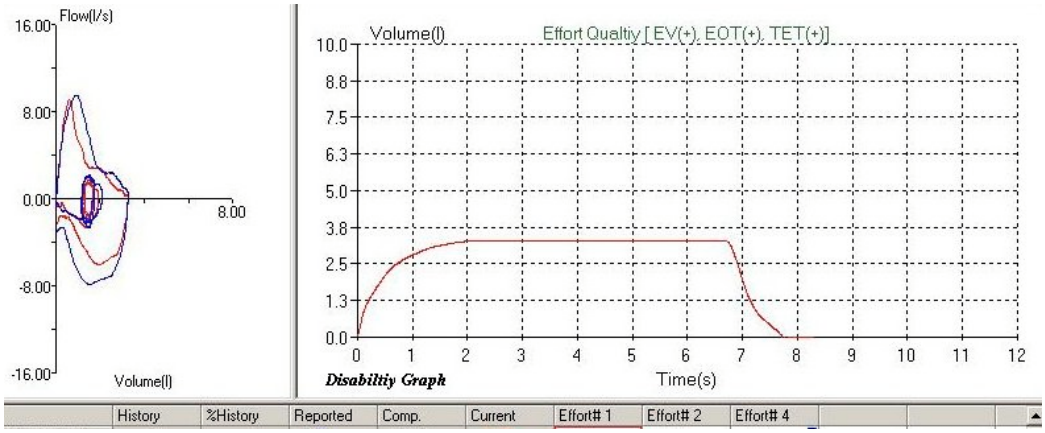



Figure 5-4. Sample FVC Disability Graph

*Summary of FVC Options*

1. Following is a description of the Main FVC options, which are the ones displayed along the top of the FVC window:

**Start Test -** Initiates the test procedure.

**Choose -** When you have completed more than one test, click on this option to select a test as the Current test. The Current effort data will be highlighted in red and the loop of the current effort will display in red on the Flow-Volume graph. You may also click on the column heading in the datasheet to select it.
**Delete -** When you wish to delete an effort, make it the Current effort by selecting it in the Choose option or clicking on the Effort # column header. Then click on Delete.
**Save -** To save an effort just completed, click on Save.
**Reported -** Allows you to override the ATS Best Test algorithm, which the program uses to automatically select the Reported effort. Refer to *FVC Datasheet, Reported*.
**Undo -** Allows you to restore the last-deleted effort. This will only work if you have not selected Save since the last deletion.

*More FVC Options*

2. The right-click context menus provide other options. Point to either of four areas: the flow-volume graph, volume-time graph (or the Disability Graph, if the VT graph does not display), or the datasheet and right-click on the mouse. The following menus will display:

*Right-Click on Flow-Volume Graph:*

**Copy Flow/Volume Graph -** Copies the graph to the clipboard and enables you to paste it where you wish.
**Print Flow/Volume Graph -** prints the graph
**History -** compares the reported (best) results with the patient's selected test results from the previous study. This will be labeled the History column. If unchecked, compares Reported results with patient's predicted values in Predicted column and % of Predicted column.
**Volume Scale (L) = *n*** - shows a volume scale on graph of 0 - *n* (*n* represents the number shown) liters
**Auto Scale Volume** - volume scale based on patient's predicted values

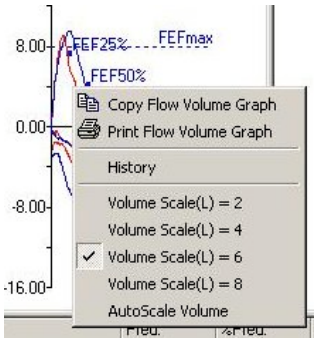



Figure 5-5. The Right-Click Menu for the Flow-Volume Loop

*Right-Click on Volume-Time Graph:*

**Copy Volume/Time Graph -** Copies the graph to the clipboard and enables you to paste it where you wish.
**Print Volume/Time Graph** - prints the graph
**View Volume-Time Graph -** Changes the view to the Volume-Time graph if the disability graph displays.
**View Disability Graph -** Changes the view to the Disability graph if the Volume-Time graph displays.
**Volume Scale (L) = *n* -** shows a volume scale on graph of 0 - *n* liters
**Auto Scale Volume -** volume scale based on patient's predicted values
**Time Scale (s) = *n* -** shows a time scale of 0 - *n* seconds\

*Right-Click on the Disability Graph:*

**Copy Disability Graph** - Copies the graph to the clipboard and enables you to paste it where you wish.
**Print Disability Graph** - Prints the graph
**View Volume-Time Graph** - Changes the view to the VT graph if the disability graph displays.

**View Disability Graph** - Changes the view to the Disability graph if the VT graph displays.
**Graph All Disability Efforts** - All Disability Tracings will be overlaid on the graph.

*Right-click on Datasheet*

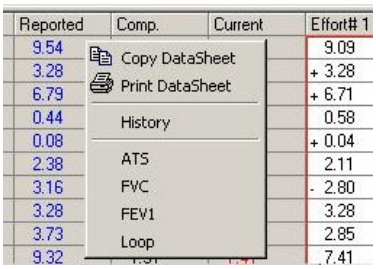



Figure 5-6. The Right-Click Menu for the FVC Datasheet

**Copy Datasheet -** Copies the data to the clipboard and enables you to paste it where you wish.
**Print Datasheet -** prints the datasheet
**History -** compares the Reported (best) results with the patient's selected test results from the previous study. This will be labeled the History column. If unchecked, compares Reported results with patient's predicted values in Predicted column and % of Predicted column.

From the four options below you may select a criterion that the program will use to designate the Reported (best) effort out of the study.

**ATS -** The American Thoracic Society algorithm selects the best FVC and the best FEV1 (even though they may come from different tests) and takes all the other parameters from the single test with the highest sum of FVC and FEV1.
**FVC -** Allows you to replace the ATS-selected Reported effort with the FVC from another effort. Make the new effort current and click on FVC.
**FEV1** - Allows you to replace the ATS-selected Reported effort with the FEV1 from another effort. Make the new effort current and click on FVC.
**Loop** - Allows you to replace all the data in the ATS -selected Reported effort, except for FVC and FEV1, from the single effort of your choice. Make the desired effort current and click on Loop.

**NOTE:**
Many of these options are also available on the Main Program Edit menu.

Resizing Windows and Working with the Datasheet Window

**NOTE:**
The terms *window* and *pane* are used interchangeably throughout this manual.

There are several ways to manipulate the window size and view more of the Datasheet in the FVC program:

a. Point the mouse cursor on a border between the panes and hold down the left mouse button until the double headed arrow icon displays. Still holding down the left button, drag the border until the desired size is achieved.

b. In the Datasheet section, you may use the vertical scroll bar to see more of the data.

c. To expose all of the Datasheet, click on the *View* option in the Windows bar, then select *Full Data Sheet*. To change back to the partial data sheet, select Restore to Default.

**Exiting the FVC Program**

1. When ready to leave the FVC program, be sure the desired Reported effort has been selected, as this is the one that will appear on the final Report.

2. Select Save to save the reported data.

3. Select the next desired Spirometry option.

**NOTE:**
Upon leaving the program, the screen will warn you if you have not saved data and give you an opportunity to do so.

## The MVV Test

The Maximum Voluntary Ventilation (MVV) test is defined as the total volume of air expired during a specified period with repetitive maximal respiratory effort, expressed in liters per minute, BTPS. A MVV maneuver is typically performed for 10, 12, or 15 seconds.

The MVV test may also be conducted on the Collins Body Plethysmograph, if you have this device. Refer to Section Six.

### Preparing Equipment for the MVV Test

Follow the instructions under Preparing Equipment for the FVC Test.

### MVV Calibration

If a valid calibration file for *Barometric Pressure/Temperature Probe* and for the *spirometer* (or pneumotach, if *pneumotach* is the currently selected device) are not available, MVV testing cannot be conducted. Perform and save a valid calibration for all instruments involved in the MVV test. Refer to Section Four for details.

### Performing the MVV (Maximal Voluntary Ventilation) Test

1. Before conducting the MVV test, make sure the desired patient and study are selected as described in Patient Testing. Click on the Pre/Post Rx button to the right of the patient cache to select Pre- or Post-drug testing.

2. Prepare the equipment for testing according to the setup instructions in *Preparing the equipment for FVC Testing*. If using the valve, be sure to turn on the $O_2$ tank.

3. To select the MVV test, click on *Go To* from the PLUS toolbar, followed by *MVV*. A screen with two panes will display the graph and the MVV datasheet, along with the following prompt line:

   *Start Test / Choose / Delete / Save / Reported / Undo / Drug*

4. In the description that follows, use of the balloon valve will be assumed. If using the pneumotach, refer to MVV Test with pneumotach. If using the spirometer directly without the valve, refer to *MVV Test with Spirometer*.

5. Explain the procedure to the patient, demonstrating if necessary. Attach a noseclip.

6. Select Start Test by clicking on the button or holding down the <Control> key while pressing the <T> key. The following prompt is displayed:

   *Please wait while spirometer is emptied, purged,*
   *and filled to its initial volume.*

7. The spirometer bell will rise automatically to 5 liters in order to prevent "bottoming out" or "topping off" during the test. The volume reading will display in a box as it rises. The prompt is updated to read:

   *Insure that the patient is connected to the breathing circuit,*
   *press the spacebar to start test.*

8. Connect the patient to the mouthpiece and direct him/her to breathe normally.

9. When the patient is comfortable with the mouthpiece, direct him to begin maximal inspirations and expirations. As soon as the patient starts the maneuver, press the spacebar. Verbally coax the patient during the test to ensure a maximum effort. Once the maneuver begins, the prompt reads:

   *Hit space to end Test, esc. to abort.*

10. Press the spacebar only if you wish the test to end before the time previously selected. Otherwise, the test will end automatically at the time selected.

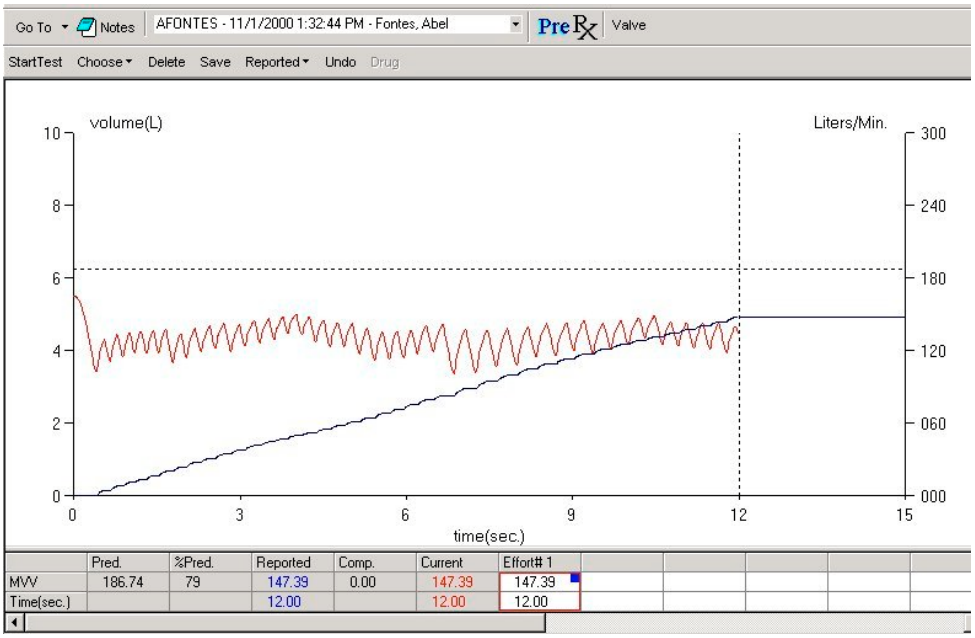



Figure 5-7. A Completed MVV Test

11. Refer to *Ending the MVV Test* and *MVV Duration* for details on ending the test prematurely. Refer to MVV Review for an explanation of the resulting data and graphs.

12. You may save 8 pre-drug MVV tests per study. The data for the 8 most recently performed tests will display in the chart described above. If you attempt to perform a ninth test, the program will prompt you to discard one effort in order to perform another.

13. You will be prompted to save MVV data when you exit the test module. If you have not saved data before exiting, do so by clicking on the *Save* button.

*Ending the MVV Test*

1. During the MVV test, press the spacebar only if you wish the test to end before the time previously selected. Otherwise, the test will end automatically at the selected time.

2. If the test ends automatically, i.e., at the vertical line representing the target duration time, the blue integrator tracing will plateau until it reaches the value on the right-hand axis representing the calculated MVV for one minute.

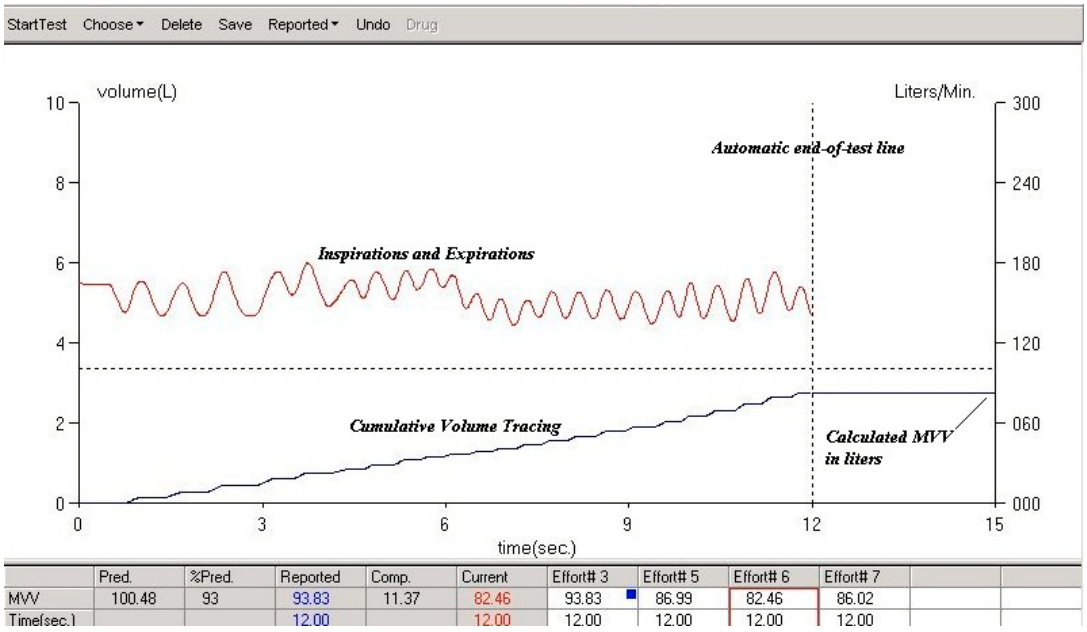



Figure 5-8. Appearance of MVV Graph When Test is Ended Automatically

3. If the test is ended after 6 seconds but before the selected time, the MVV will be extrapolated from the actual test duration. The red MVV real-time tracing ends at the time where you hit the spacebar, for example, at 8 seconds. The blue tracing will continue until it reaches the target duration line. The tracing will then plateau until it reaches the value on the right-hand axis representing the calculated MVV for one minute.

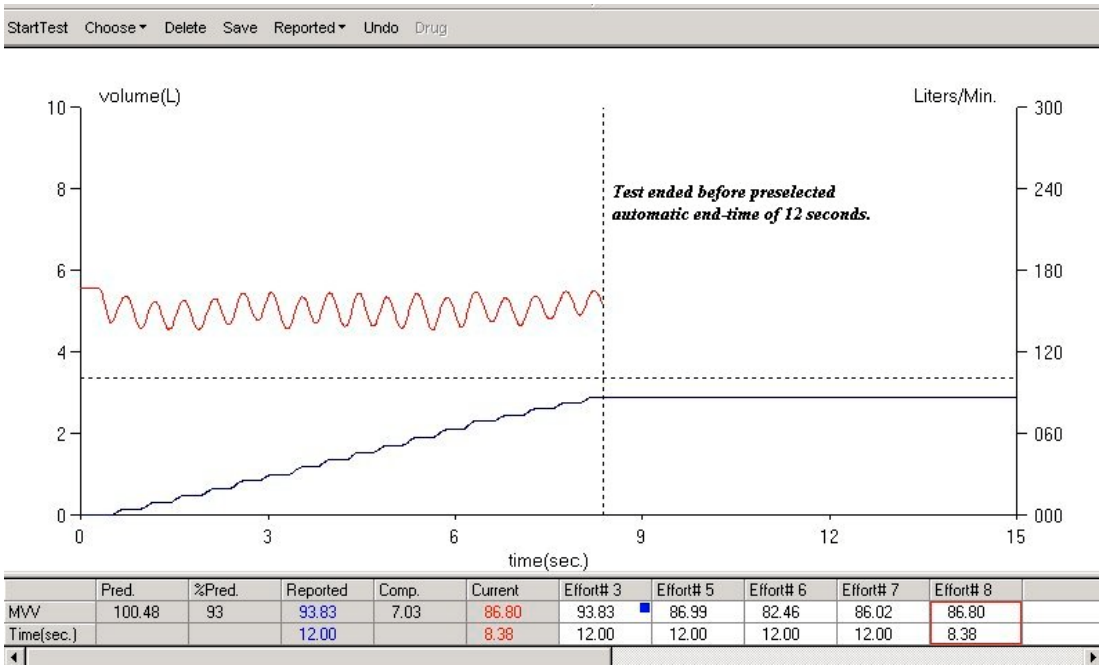



Figure 5-9. Appearance of MVV Graph When Test is Ended Early

*MVV Duration*

1. The default MVV duration time is 12 seconds. ATS recommends that the MVV maneuver last no longer than 15 seconds and no less than 12 seconds, providing the patient can sustain the maneuver.

2. The MVV result is always calculated for 1 minute based on the actual total volume expired. In other words, the volume expired in 12 seconds will be multiplied by 5 to obtain the final MVV.

3. If the test ends before the selected time period is up, the MVV will still be calculated based on the actual volume expired. For example, if you have selected 12 seconds, but the test lasts only 10 seconds, the program will multiply the volume by 6 to obtain the final MVV.

*MVV Test with Pneumotach*

1. Refer to Preparing the Equipment for the FVC Test for directions on how to set up the pneumotach.

2. Be sure you have selected the Pneumotach for the testing device in FVC Configuration.

3. The procedure for conducting the MVV with the pneumotach is the same as that for the spirometer/valve, except that the prompts to wait while the spirometer rises to the starting volume are omitted. The program begins with:

> *Insure that the patient is connected to the breathing circuit,*
> *press the spacebar to start test.*

4. The rest of the procedure is the same.

*MVV Test with Spirometer*

1. If you conduct the MVV test while connected directly to the Spirometer instead of the valve, the procedure is basically the same as for Conducting the MVV Test, except that you will be prompted to manually position the bell to the 5-liter starting point.

2. Make sure the system is set up for working directly with the spirometer, as described in Preparing Equipment for FVC Testing.

3. The remainder of the test proceeds as described under testing with the balloon valve above.

**MVV Review**

1. At the completion of the test, the following can be observed:

   The real-time **MVV tracing** will be recorded on the graph.
   The **tabular data** will display in the dastasheet at the bottom of the screen.

2. In order to delete an effort, click on it to make it current. Then select Delete from the prompt line. In order to undelete, select Undo from the prompt line.

3. Click on Reported in order to select the Best Effort criteria.

4. To save the data, click on Save from the Main MVV menu.

5. If you have more than one MVV, to select an effort as the Current one, click on Choose or on the heading in the datasheet. The effort will be highlighted in red in the tabular column and will display on the graph.

6. Each of the above options is described in detail under its own heading.

*MVV Tabular Data*

The MVV tabular data is listed in the bottom pane of the 2-part MVV screen. You may scroll this screen from side to side to view more of it than fits in the window. The row headings are for the MVV test parameters, which are MVV and Time. Refer to The FVC Datasheet for a description of the column headings.

*MVV Reported Effort*

1. When reviewing MVV data, one of the columns in the datasheet will be highlighted in blue. This column, labeled Reported, contains the best effort according to whatever criteria you have selected in the Reported option or in the right-click options.

2. Position the mouse over the datasheet and right-click. In the bottom pane of the resulting menu are the following choices:

   **AutoSelect:** Allows the program to select the best test.
   **MVV:** Allows the user to select the best test. Simply select the desired test to make it current; then right-click and select MVV.

3. These options are also selectable from the Reported option in the Main MVV menu.

**NOTE:**
If you change the best-test criteria after having conducted several tests, the data in the Reported column may change.

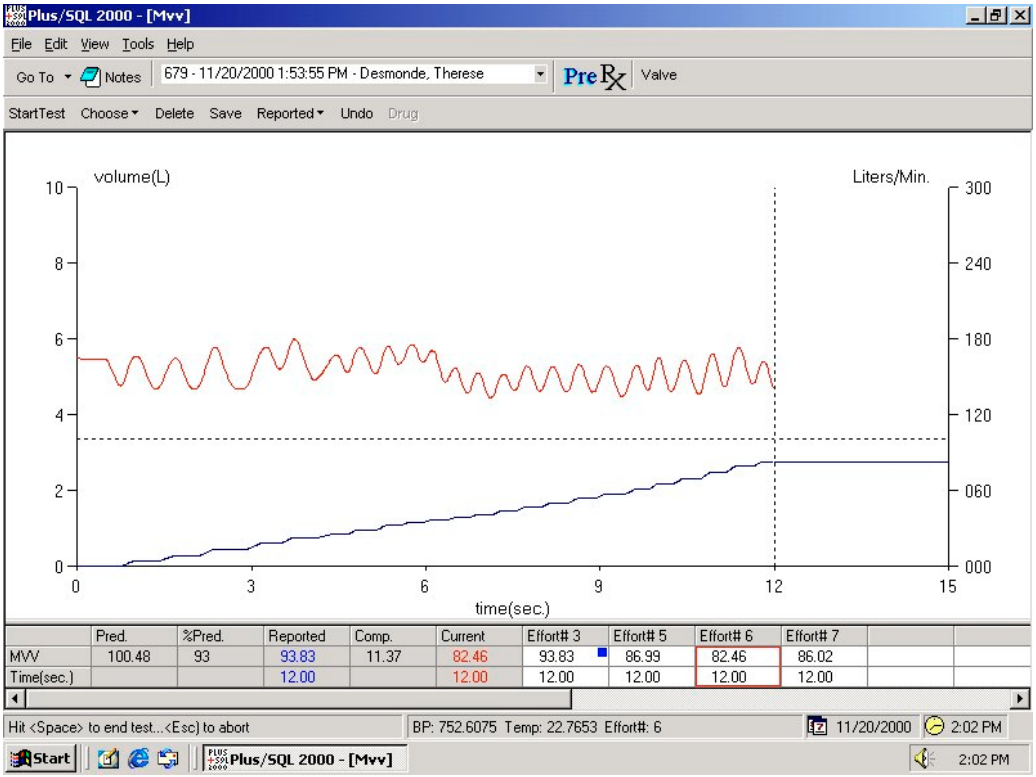



Figure 5-10. Sample MVV Reported Effort

*MVV Graph*

1. When you select the Maximum Voluntary Ventilation test, the MVV graph will display in the top pane. The x-axis represents time in seconds; the y-axis represents volume in liters. The vertical axis to the right represents the calculated MVV in liters for one minute based on the total volume expired during the maneuver. A vertical line represents the target duration time selected. A horizontal line represents the patient's predicted MVV.

2. As you conduct the test, you will see the following: The patient's inspirations and expirations are represented in real-time by the red line on the MVV volume/time graph. This line is the same as the corresponding kymograph tracing of the MVV if the system has a kymograph. The cumulative volume of air expired over time is represented by the ascending blue line. The right-hand vertical axis represents the calculated MVV in liters for one minute based on the total volume expired during the maneuver.

*Summary of MVV Options*

The Main MVV options are the same as those described under Main FVC options.

*More MVV Options*

1. Use the right-click menus for other options. Point to either of the two panes in the MVV window: the graph or the datasheet and right-click on the mouse. The following menus will display:

*Right-Click on Graph:*

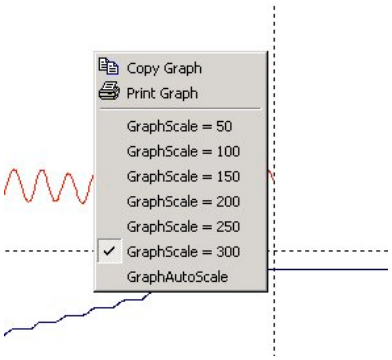



Figure 5-11. The MVV Graph Right-Click Menu

**Copy Graph -** Copies the graph to the clipboard and enables you to paste it where you wish.
**Print Graph -** prints the graph
**Graph Scale (L) = *n* -** on the cumulative axis, shows a volume scale of 0 to whatever value, in liters, is selected
**Graph Autoscale -** volume scale based on size of graph produced. If no data produced yet, you will get a full-scale graph with this option.

*Right-click on Datasheet*

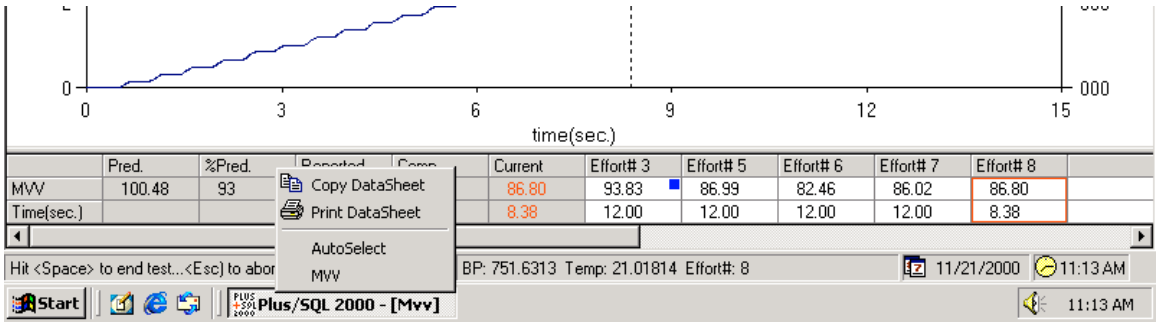



Figure 5-12. The MVV Datasheet Right-Click Menu

**Copy Datasheet -** Copies the data to the clipboard and enables you to paste it where you wish.
**Print Datasheet -** prints the datasheet
**Autoselect -** Allows the program to select the Reported (Best) effort.
**MVV -** Allows the user to select the best test.

**NOTES:**

These last two options are also selectable from the Reported option in the Main MVV menu.

Many of the options in this Summary are also available on the Main Program Edit menu.

**Exiting the MVV Program**

1. When ready to leave the MVV program, be sure the desired Reported effort has been selected, as this is the one that will appear on the final Report.

2. Select Save to save the reported data.

3. Select the next desired Spirometry option.

**NOTE:**
Upon leaving the program, the screen will warn you if you have not saved data and give you an opportunity to do so.

## The Lung Volumes Test – Helium Dilution Method

**NOTE:**
If you have the Collins CPL, you will be using the Helium Dilution Method of measuring Lung Volumes (described below). If you have the Collins Eagle, you will be using the Nitrogen Washout method (described under *The Lung Volumes Test - $N_2$ Washout Method*, which follows the He dilution method).

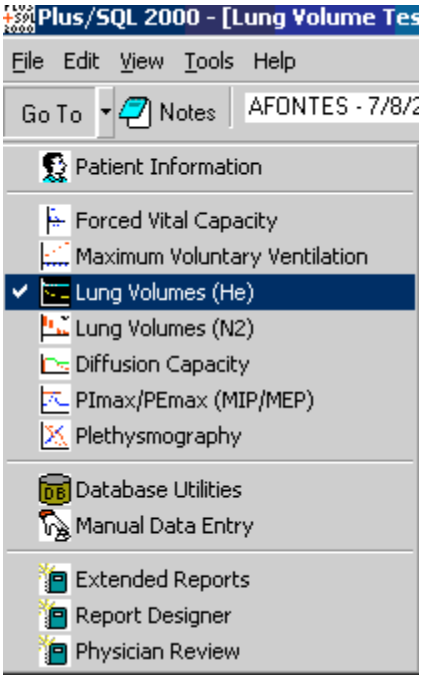



Figure 5-13. He Dilution Test Selected from the GoTo Menu

1. The Lung Volumes test combines the FRC and SVC maneuvers in order to calculate a complete set of Lung Volumes.

2. The FRC (Functional Residual Capacity) is the volume of air remaining in the lungs at the end-expiratory position (after a normal, quiet inhalation). This is calculated as the sum of the residual volume (RV) and the Expiratory Reserve Volume (ERV).

3. The SVC (Slow Vital Capacity) is the maximum amount of air expired from the point of maximum inspiration without attention to speed. However, a maximal effort is still required through the end-expiration.

**Preparing Equipment for the Lung Volumes Test**

1. Refer to Preparing the System for PFT Testing in the CPL hardware manual for more information about tubing connections between the balloon valve and the CPL, pneumotach connections, etc.

2. After the basic connections have been made, attach a DC-2 filter to the patient port on the front of the Balloon Valve. The DC-2 is a low-resistance barrier filter designed for use in preventing patient droplet contamination of pulmonary equipment, thereby preventing patient cross-contamination. The DC-2 filter may be used alone. However, if the patient has a difficult time maintaining a lip seal on the DC-2 opening, a mouthpiece may be attached to the DC-2.

3. Make sure that the tank of $O_2$ for operating the Balloon Valve is connected to the blue inlet on the lower rear panel of the CPL and that it is turned on. To do so, turn the regulator stem counterclockwise with a tank wrench. To turn the tank off, turn the regulator stem clockwise.

4. Do the same for the Helium tank (orange inlet). Refer to Preparing the Gas Tanks in the CPL hardware manual.

**Lung Volumes Calibration**

1. If a valid calibration file for each of the devices involved in Lung Volumes testing is not available, Lung Volumes testing cannot be conducted. Refer to *Section Four -- Calibration* for details.

2. Perform and save a valid calibration file for any of the devices that require valid calibration file:

*Barometric Pressure/Temperature Probe*
*Pneumotach*
*Spirometer*
*Gas Analyzers*

**Conducting the Lung Volumes Test**

**FRC CAUTION:**

Since the patient breathes from the closed CPL system during the FRC maneuver, it is crucial to ensure an adequate oxygen supply and adequate gas pressure. The computer regulates the oxygen supply automatically. However, monitor the baseline carefully to detect any drop. Before the maneuver, tell the patient that if he experiences any physical discomfort while breathing from the CPL (dizziness, dyspnea, nausea, etc.), he should immediately remove the mouthpiece from his mouth. This is especially important for patients with COPD and/or cardiac problems. Periodically ask the patient if he is experiencing any discomfort during the closed breathing session, because some patients might be too inhibited to remove the mouthpiece voluntarily.

*Conducting the FRC Test*

1. Before conducting the Lung Volumes test, make sure the desired patient and study are selected as described in Patient Testing. Click on the Pre/Post Rx button to the right of the patient cache to select Pre- or Post-drug testing.

2. Click on the GoTo button. You will see two lung volume options, (He and N2). Select Lung Volumes (He).

3. A screen with three panes will display the FRC graph with the predicted baseline drawn, the SVC graph, and the Lung Volumes Datasheet, along with the following prompt line:

*Start Test / Choose SVC/ Choose FRC / FRC Data/ Delete / Save / Reported / Undo*

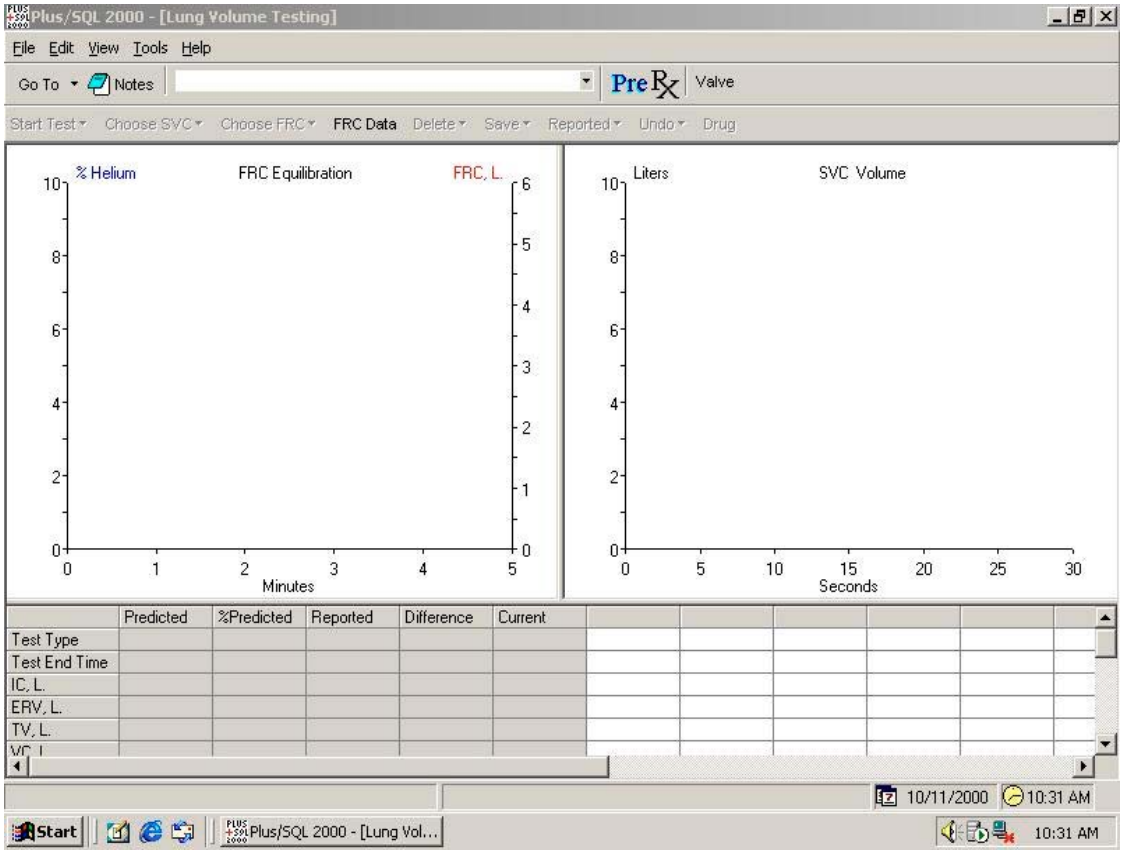



Figure 5-14. Opening Screen for the Lung Volumes Test

3. If the right pane shows the detailed FRC datasheet and you want the SVC graph, select SVC graph and the SVC graph will display. Note in the Main prompt line that FRC Data will toggle with SVC Graph depending on which one you choose.

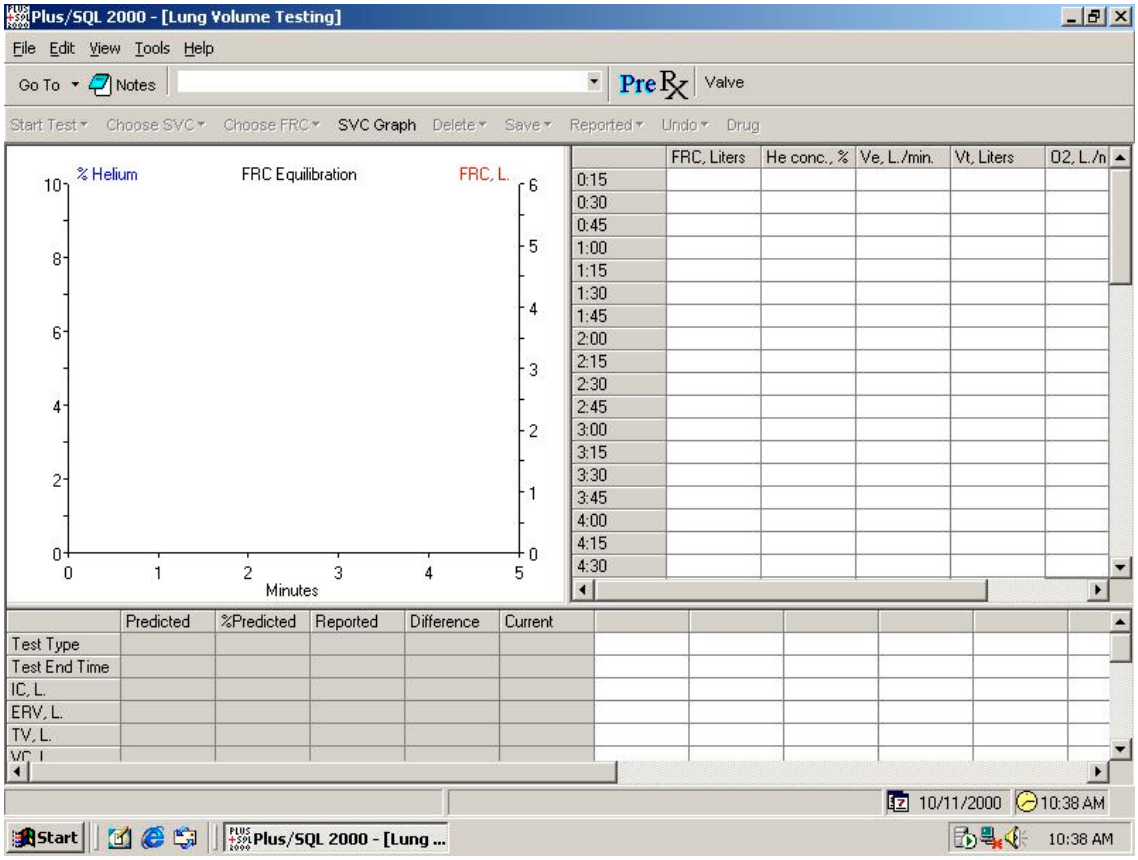



Figure 5-15. Opening Lung Volumes Screen with Detailed Datasheet

4. You may change the size of the panels by pointing to a border and dragging it. For example, to expand the view of the table, point to the top table border and drag it upward. Drag this line downward to enlarge the graphs. You may also scroll the table horizontally to see more of it.

5. Prepare the equipment for testing according to the setup instructions in *Preparing the Equipment for Testing*. Be sure to turn on the $O_2$ and Helium tanks.

6. In the following instructions, subsequent program messages will be written in italic.

7. Select *Start Test*. The program will display a drop-down menu allowing you to choose between conducting the FRC, SVC, or Both. We will assume here that Both is selected.

8. The FRC spirometer volume graph, the FRC equilibration graph with the patient's predicted FRC shown as a black tracing, and the FRC datasheet will display. The following messages will display in succession:

   *Purging the Spirometer and the Helium and Oxygen Lines.*

   *Purging the Helium cell with air and reading its offset (zero). Please wait while the offset reading stabilizers.*

9. Readings will display for:

   *Spirometer Volume:*
   *Helium Offset:*
   *Time in Seconds:*

   *Mixing and calibrating with a full-scale helium mixture (span). Please wait while helium reading stabilizes*

   *Spirometer Volume:*

*Net Helium Reading:*
*Time in Seconds:*

*Diluting with air to the starting Helium mixture. Please wait while the helium reading stabilizes.*

*Spirometer Volume:*
*Net Helium Reading:*
*Time in Seconds:*

*Insure that the patient is breathing comfortably through a mouthpiece. Press the spacebar once to review the patient's tidal breathing. Press the spacebar a second time to switch the patient in and begin testing.*

*Start Abort*

10. Explain the procedure to the patient, demonstrating if necessary. Attach a noseclip.

11. Connect the patient to the mouthpiece on the valve and direct him/her to breathe normally.

12. Press the spacebar.

13. A tracing of the patient's tidal breathing will display. The program will display the message:

    *Press <Spacebar> anytime to initiate automatic switch-in of patient.*

14. Wait for an even tidal breath tracing. When the patient appears comfortable at the mouthpiece and at an end-expiration point, click on Start or press the spacebar to connect him to system air.

15. Direct the patient to continue normal breathing.

16. After switch-in, you will see the following tracings:

    **On the volume graph:**
    *horizontal red tracing:* The baseline, in other words, the volume at which the patient was breathing before being switched in.
    *horizontal blue tracing:* The adjusted baseline, the volume at which the patient was breathing after being switched in.

The distance between these two lines represents the shift in breathing level, known as the switch-in error, for which the program corrects. If there was no shift in breathing level, this will be a solid line.

*Red volume tracing*: Represents the patient's end-tidal breathing points.

**On the equilibration graph:**
*black line:* Represents the patient's predicted FRC.
*blue tracing:* Represents the helium concentration, which corresponds to the Helium concentration readings displayed every 15 seconds in the FRC datasheet to the left of the equilibration graph.
*red tracing:* represents the FRC in liters.

These tracings allow you to accurately follow the distribution of ventilation and to pinpoint the approximate position of equilibration. This is the point at which there is an equal distribution of gas between the patient's lungs and the CPL; where the lines flatten out is the approximate equilibration point.

**On the FRC Datasheet:**
*Numerical data*, including the helium concentration readings, displays every 15 seconds. When you receive 3 successive helium readings within 0.05 of each other, the patient is equilibrated. Refer to the following example:

| Min | He% |
|---|---|
| 3:00 | 5.15 |
| 3:15 | 5.16 |
| 3:30 | 5.15 |

17. When equilibration has been reached, the program will display a message indicating so and directing you to press the spacebar to continue.

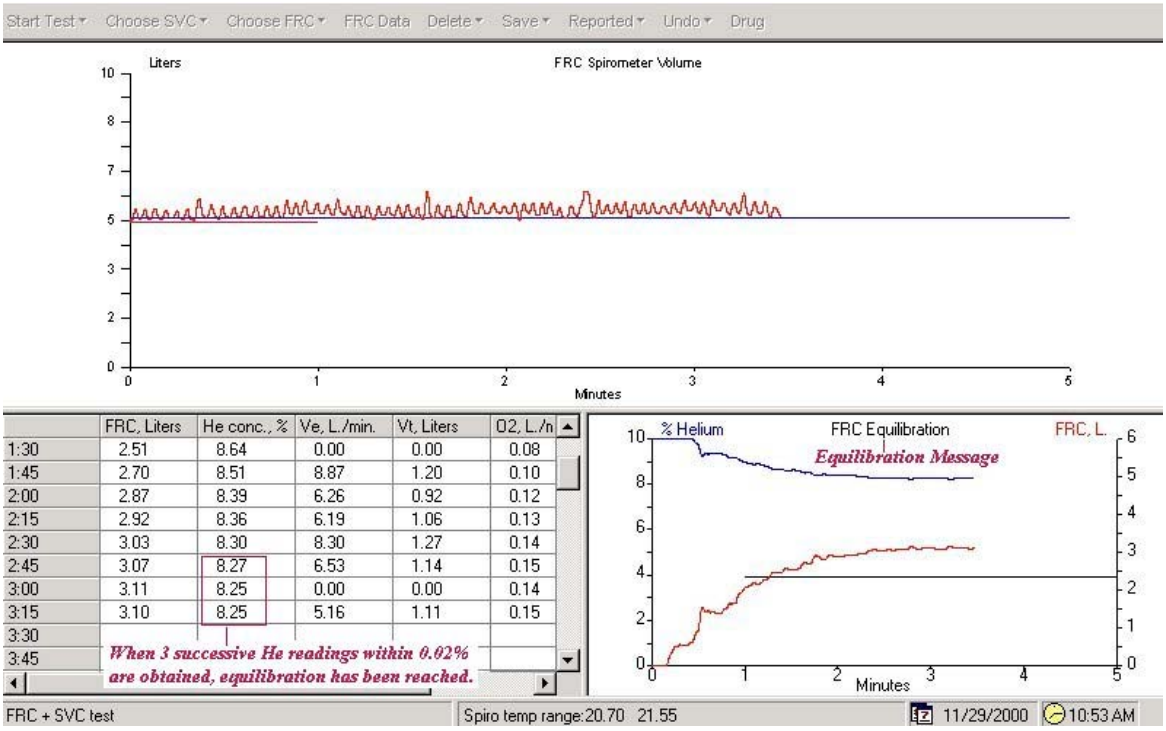



Figure 5-16. A Completed FRC Test

*Conducting the SVC Test*

18. Press the Spacebar once equilibration has been reached. The graph for the SVC test will display. The program allows 30, 45, or 60 seconds in which to complete the maneuver, depending on what you selected for SVC options.

19. The program displays the patient's tidal breathing on the SVC graph. A minimum of three recorded tidal breaths is needed to establish a baseline for the SVC maneuver. When a baseline has been established, the program draws a vertical line on the tidal breath tracing as an indication that the SVC maneuver is to be performed and displays the following message:

    *Start Maximal Effort*

20. As soon as this message displays, direct the patient to inspire maximally to Total Lung Capacity (TLC) without attention to speed; the SVC tracing of the patient's breathing goes down. When TLC is reached, instruct the patient to expire maximally to Residual Volume (RV), again without attention to speed; the SVC tracing of the patient breathing rises. Verbally coax the patient during the maneuver to ensure a maximum effort. As the patient begins the next inspiration, press the spacebar to end the test. See *Alternate SVC Method* also.

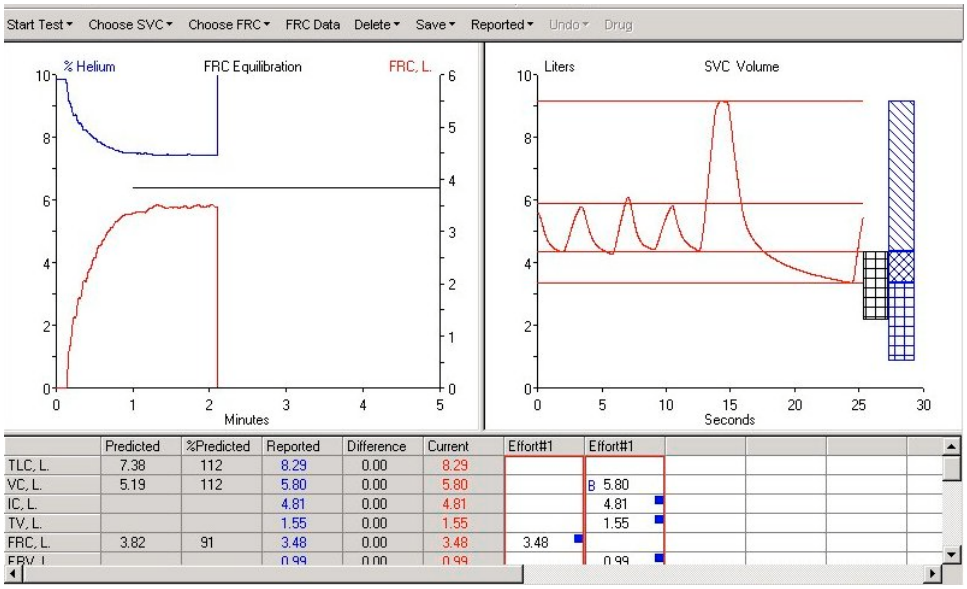



Figure 5-17. A Completed SVC Test

21. Refer to *Lung Volumes Review* for an explanation of the resulting data and graphs.

**NOTE:**
Be sure to allow enough time for residual helium to be flushed from the patient's lungs before conducting another FRC test. If not enough time has elapsed when you go to conduct another test, the program will inform you of such.

22. You may accept 8 pre-drug Lung Volumes tests for one study. The data for the 8 most recently performed tests will display in the chart described above. When you go to perform a ninth test, the program will prompt you to discard one effort in order to perform another.

23. You will be prompted to save Lung Volumes data when you exit the test module. If you have not saved data before exiting, do so by click on the Save button.

*Alternate SVC Method*

An alternate way to perform the SVC test is to breathe tidally, then when the vertical line displays, to first expire to RV (Residual Volume), then inspire to TLC (Total Lung Capacity), then expire to RV again, pressing the spacebar at the end of the maneuver.

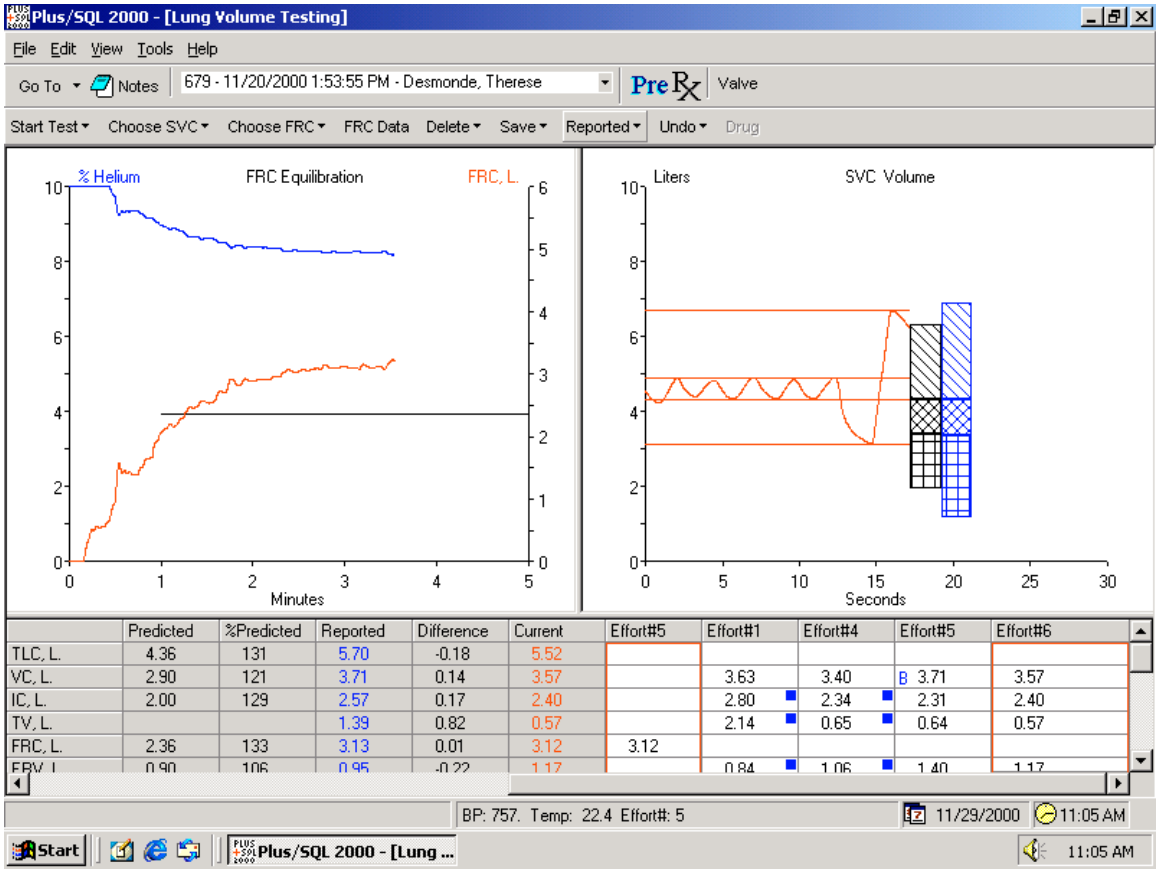

Plus/SQL 2000 - [Lung Volume Testing]
File Edit View Tools Help
Go To Notes
679 - 11/20/2000 1:53:55 PM - Desmonde, Therese
Pre Rx
Valve
Start Test Choose SVC Choose FRC FRC Data Delete Save Reported Undo Drug
% Helium
FRC Equilibration
FRC, L.
Minutes
Liters
SVC Volume
Seconds
Predicted %Predicted Reported Difference Current Effort#5 Effort#1 Effort#4 Effort#5 Effort#6
TLC, L. 4.36 131 5.70 -0.18 5.52
VC, L. 2.90 121 3.71 0.14 3.57 3.63 3.40 B 3.71 3.57
IC, L. 2.00 129 2.57 0.17 2.40 2.80 2.34 2.31 2.40
TV, L. 1.39 0.82 0.57 2.14 0.65 0.64 0.57
FRC, L. 2.36 133 3.13 0.01 3.12 3.12
BP: 757. Temp: 22.4 Effort#: 5
11/29/2000
11:05 AM
Start
Plus/SQL 2000 - [Lung ...
11:05 AM

Figure 5-18. The Alternate SVC Method

*Lungs Volumes, FRC or SVC Alone*

*FRC Test Alone*

If conducting the FRC test alone, select Start Test. Then select FRC. Proceed according to directions in Lung Volumes, Conducting Test. The FRC test ends when the patient has equilibrated and you press the spacebar.

*SVC Test Alone*

1. If conducting the SVC test alone, it may be done using the valve or while attached to the spirometer directly. See Preparing the Valve for Testing in the CPL Hardware section. In the following instructions, we will assume use of the valve.

2. Select Start Test. Then select SVC.

   *Please wait while the Spirometer is emptied and purged and filled to its initial volume.*

3. Wait as directed.

4. Insure that the patient is breathing comfortably through the mouthpiece and press the Spacebar to start the test. Conduct the test as described in the latter portion of Conducting the Lung Volumes test.

**Lung Volumes Review**

1. At the completion of the test, the following can be observed:

   The **SVC and FRC tracings** for the current effort will display.
   If the **detailed FRC datasheet** for the current effort is active, this data will be displayed. If it is not active, you may click on **FRC Data/SVC Graph** toggle button from the Main Menu. The readings for every 15 seconds of the current FRC maneuver will display. See more about this feature under *FRC Helium Readings*.
   The **datasheet** for all efforts performed will display in the table below these two graphs. It will be noted whether the data for the effort comes from an FRC test, an SVC test, or both.

2. In order to delete an effort, click on it to make it current. Then select Delete from the prompt line. In order to undelete, select Undo from the prompt line.

3. To save the data, click on Save from the Main Lung Volumes menu.

4. Each of the above options is described in detail under its own heading.

*FRC Helium Readings*

1. There are two datasheets in the Lungs Volumes program. One displays all the efforts saved and is displayed in the bottom pane. The other is the FRC detailed datasheet, which displays the FRC data obtained every 15 seconds during the current test. The helium value from the reading at which the patient equilibrated is known as Helium 3. Refer to *Lung Volumes Datasheet* for more details.

2. After you have completed the effort, you may wish to change the FRC equilibration data for that particular effort to another one of the readings obtained during the test. To do so:

3. If the detailed FRC datasheet does not display, from the Main menu, select this feature using the FRC Data/SVC Graph toggle.

4. Click on the desired reading in the FRC detailed datasheet to highlight that row. You will see the calculated data for the Current effort column in the summary datasheet below be updated as you change readings.

5. Click on Save to save this data.

6. The headings for the detailed FRC datasheet are explained below.

   **FRC, Liters:** The patient's FRC (functional residual capacity), in liters for the given time reading.
   **He Conc, %:** The patient's Helium concentration.
   **Ve, L/min.:** The minute ventilation, the volume of air exhaled from the lungs in one minute.
   **Vt, Liters:** Tidal volume, the volume of air inhaled or exhaled in each breath.
   **O2, Liters/min**. The amount of oxygen added to the system during the test in order to maintain the system volume.

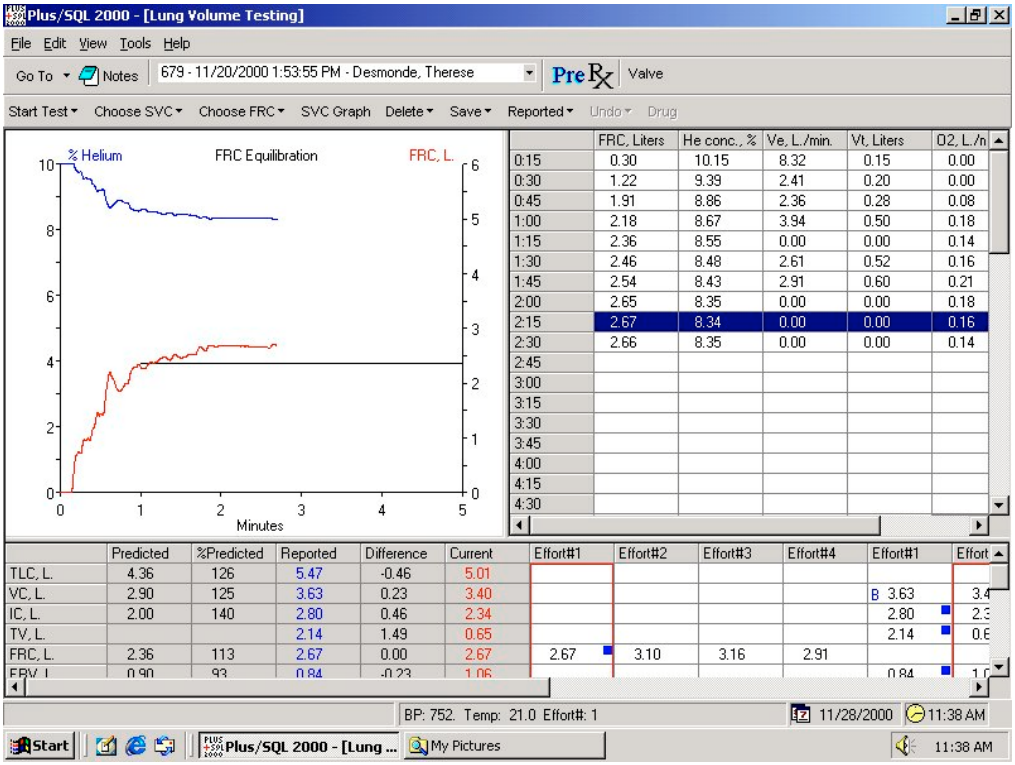

Plus/SQL 2000 - [Lung Volume Testing]
File Edit View Tools Help
Go To Notes
679 - 11/20/2000 1:53:55 PM - Desmonde, Therese
PreRx Valve
Start Test Choose SVC Choose FRC SVC Graph Delete Save Reported Undo Drug
% Helium
FRC Equilibration
FRC, L.
Minutes
FRC, Liters He conc., % Ve, L./min. Vt, Liters O2, L./n
0:15 0.30 10.15 8.32 0.15 0.00
0:30 1.22 9.39 2.41 0.20 0.00
0:45 1.91 8.86 2.36 0.28 0.08
1:00 2.18 8.67 3.94 0.50 0.18
1:15 2.36 8.55 0.00 0.00 0.14
1:30 2.46 8.48 2.61 0.52 0.16
1:45 2.54 8.43 2.91 0.60 0.21
2:00 2.65 8.35 0.00 0.00 0.18
2:15 2.67 8.34 0.00 0.00 0.16
2:30 2.66 8.35 0.00 0.00 0.14
Predicted %Predicted Reported Difference Current Effort#1 Effort#2 Effort#3 Effort#4 Effort#1 Effort
TLC, L. 4.36 126 5.47 -0.46 5.01
VC, L. 2.90 125 3.63 0.23 3.40 B 3.63
IC, L. 2.00 140 2.80 0.46 2.34 2.80
TV, L. 2.14 1.49 0.65 2.14
FRC, L. 2.36 113 2.67 0.00 2.67 2.67 3.10 3.16 2.91
BP: 752. Temp: 21.0 Effort#: 1
11/28/2000 11:38 AM
Start Plus/SQL 2000 - [Lung ... My Pictures 11:38 AM

Figure 5-19. Detailed FRC Datasheet Showing Helium Readings

*Lung Volumes Datasheet*

1. The Lung Volumes Datasheet is located in the bottom pane of the 3-part FRC screen. You may scroll this screen up and down and from side to side to view more of it than fits in the window. The row headings are for Lung Volumes test parameters. The column headings are identified by effort number and by other categories described below.

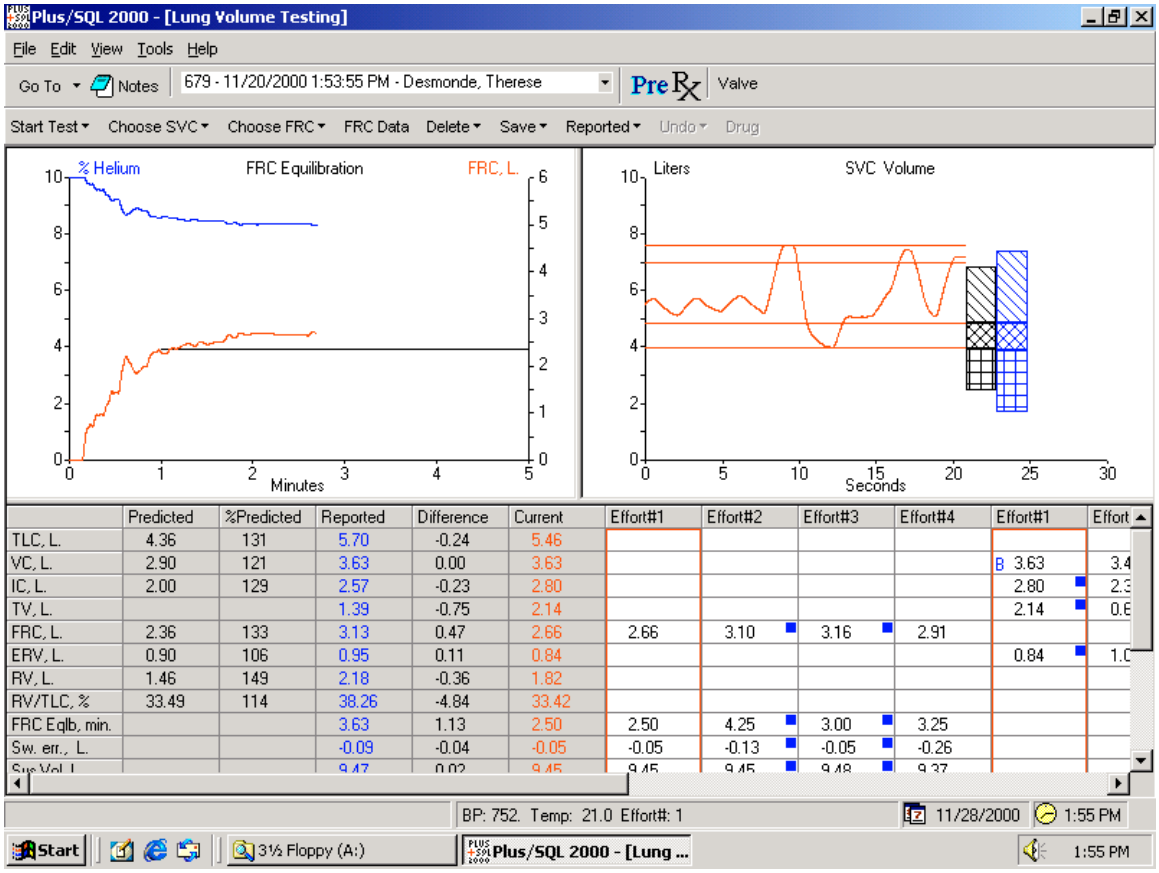

Plus/SQL 2000 - [Lung Volume Testing]
File Edit View Tools Help
Go To Notes
679 - 11/20/2000 1:53:55 PM - Desmonde, Therese
Pre Rx
Valve
Start Test Choose SVC Choose FRC FRC Data Delete Save Reported Undo Drug
% Helium
FRC Equilibration
FRC, L.
Minutes
Liters
SVC Volume
Seconds
Predicted %Predicted Reported Difference Current Effort#1 Effort#2 Effort#3 Effort#4 Effort#1
TLC, L. 4.36 131 5.70 -0.24 5.46
VC, L. 2.90 121 3.63 0.00 3.63 B 3.63
IC, L. 2.00 129 2.57 -0.23 2.80 2.80
TV, L. 1.39 -0.75 2.14 2.14
FRC, L. 2.36 133 3.13 0.47 2.66 2.66 3.10 3.16 2.91
ERV, L. 0.90 106 0.95 0.11 0.84 0.84
RV, L. 1.46 149 2.18 -0.36 1.82
RV/TLC, % 33.49 114 38.26 -4.84 33.42
FRC Eqlb, min. 3.63 1.13 2.50 2.50 4.25 3.00 3.25
Sw. err., L. -0.09 -0.04 -0.05 -0.05 -0.13 -0.05 -0.26
BP: 752. Temp: 21.0 Effort#: 1
11/28/2000
1:55 PM
Start
3½ Floppy (A:)
Plus/SQL 2000 - [Lung ...
1:55 PM

Figure 5-20. The Lung Volumes Datasheet

2. Only if you have conducted both an FRC and an SVC will you get a complete set of Lungs Volumes parameters. This is because some of the parameters have to be calculated from both sets of data.

**Predicted:** This column will contain the patient's predicted values, in other words, normal values. This gives the user a basis for comparing the Reported (best) test results.

**% Predicted:** For each parameter, the %Predicted column shows what percentage of the predicted value the Reported (best) value represents. For example, if the Predicted FRC is 2.78 liters and the Reported one is 3.05 Liters, the %Predicted column would show 91%.

**Effort # Columns:** These columns contain the results of the numerically labeled efforts. If one of these efforts is currently selected, it will also display in the Current Column. If one of these efforts is the Best effort, it will also display in the Reported column. Refer to Lung Volumes Reported Effort for more information about the Reported Column.

If **both an SVC and an FRC** maneuver were conducted for one effort, there will be two separate effort columns for them, one for the SVC data and one for the FRC data. They will each have the same effort number and be labeled **Both**. However, this data may be calculated together in the Current Column by clicking on both columns or by selecting **Choose FRC** and **Choose SVC** from the Main option line.

**Separately conducted FRC and SVC tests** will have different effort numbers and be labeled FRC or SVC accordingly.

**NOTE:**

Effort numbers are continued from the previous effort number, even if that effort was deleted. Thus, if you delete Efforts number 1 and 2, the next effort will still be numbered 3 and will not start over again from 1.

**Current:** This column contains the effort that is currently selected and highlighted in red. The Current column itself is highlighted by red or by whatever color you chose in Configure. Click on the desired data column heading to make it current or select Choose FRC and Choose SVC from the Main option line. This allows you to mix and match the FRC and SVC data from different efforts:

**Choose FRC** - Allows you to select the current FRC data from an effort, which contains an FRC, maneuver or both an FRC and SVC.
**Choose SVC -** Allows you to select the current SVC data from an effort, which contains an SVC, maneuver or both an SVC and FRC.
**Reported:** This column contains whichever efforts you choose to enter using the Reported command from the Main menu. It is highlighted in blue or whatever color you chose in Configure. You may enter single efforts into this column or enter in SVC and FRC data from different efforts. You may average more than one effort. In the actual effort columns, a value will have a blue box next to it if it is part of the Reported effort. Refer to Lung Volumes, Reported Effort and Averaging Results.
**Comp. (Comparison):** This column contains the numeric differences between the parameters in the Current and in the Reported column, for the sake of comparison. Note that the values will be zero if values from the Current column are the same as those in the Reported column.

3. Several of the row headings are explained below:

**Air Added:** The amount of O2 added during the test to maintain the system volume.
**He1:** The Helium reading obtained at the completion of the automatic span.
**He2:** The Helium reading obtained after the helium has been diluted with air and the meter has stabilized.
**He3:** The Helium reading obtained when the patient has equilibrated. This will be either the last reading obtained, or one that you select from the detailed FRC datasheet for that particular effort.
**FRC Equil., min.:** The amount of time it took the patient to equilibrate, in minutes.
**SW Err., L:** The "Switch-in Error" represents the baseline adjustment the system had to make if the patient was not switched into the system at exactly end tidal (FRC).
**Sys VoL, L.:** The calculated system deadspace, including any filter used.

*Lung Volumes, Discarding an Effort*

1. The program allows you to save 8 FRCs and 8 SVCs, or 8 combined efforts per study. If you have reached this limit and attempt to conduct another test, the program displays the following message:

*Maximum number of test efforts are exceeded. Must delete an effort to test.*

2. To discard an effort, simply highlight it with the mouse and click on Delete. The program will ask if you wish to delete Both, FRC only, or SVC only.

3. You may undo the delete by clicking on Undo. The program will again ask you which portion you wish to delete.

*Lung Volumes Graphs*

1. After the FRC switch-in, you will see the following tracings:

**On the volume graph:**
*horizontal red tracing:* The baseline, in other words, the volume at which the patient was breathing before being switched in.
*horizontal blue tracing:* The adjusted baseline, the volume at which the patient was breathing after being switched in.

The distance between these two lines represents the shift in breathing level, known as the switch-in error, for which the program corrects. If there was no shift in breathing level, this will be a solid line.

*Red volume tracing:* Represents the patient's end-tidal breathing points.

**On the equilibration graph:**
*Black line:* Represents the patient's predicted FRC.
*blue tracing:* Represents the helium concentration, which corresponds to the Helium concentration readings displayed every 15 seconds in the FRC datasheet to the left of the equilibration graph.
*red tracing:* represents the FRC in liters.

These tracings allow you to accurately follow the distribution of ventilation and to pinpoint the approximate position of equilibration. This is the point at which there is an equal distribution of gas between the patient's lungs and the CPL; where the lines flatten out is the approximate equilibration point.

**SVC Graph**
When the patient has equilibrated during the FRC test and you press the spacebar, the graph for the SVC test will display (if conducting both FRC and SVC). This is a volume-time graph, which displays the patient's tidal volume and the tracing of the Slow Vital Capacity maneuver.

**Review Graphs**
When the FRC and SVC tests have ended, you will get the final graphs for these maneuvers. The SVC tracing will contain a bar graph depicting the Predicted Lung Volumes in black, and the Reported Lung Volumes in Blue. From top to bottom the three divisions are Inspiratory Capacity, Expiratory Reserve Volume and Residual Volume.

*Lung Volumes Reported Effort and Averaging Results*

1. Reported data is what you choose to report as the final data on the patient report. The Reported column contains the effort(s) you choose using the Reported command from the Main menu. It is highlighted in blue or whatever color you chose in Configure.

2. You may enter single efforts into the Reported column or enter in SVC and FRC data from different efforts. You may average more than one effort. In the actual effort columns, a value will have a blue box next to it if it is part of the Reported effort.

3. To enter efforts into the Reported column, conduct the following steps.

4. Click on the desired FRC and SVC columns to make them current. (Note that these may be from different efforts.)

5. Click on Reported.

6. Click on Both to enter both the FRC and SVC into the Reported column. Click on FRC or SVC to enter just one or the other portion into the Reported column. The data entered into the Reported column will have a blue box next to it in the Current Column.

7. To make the Reported column the result of averaging, click on more efforts and then on a Reported option.

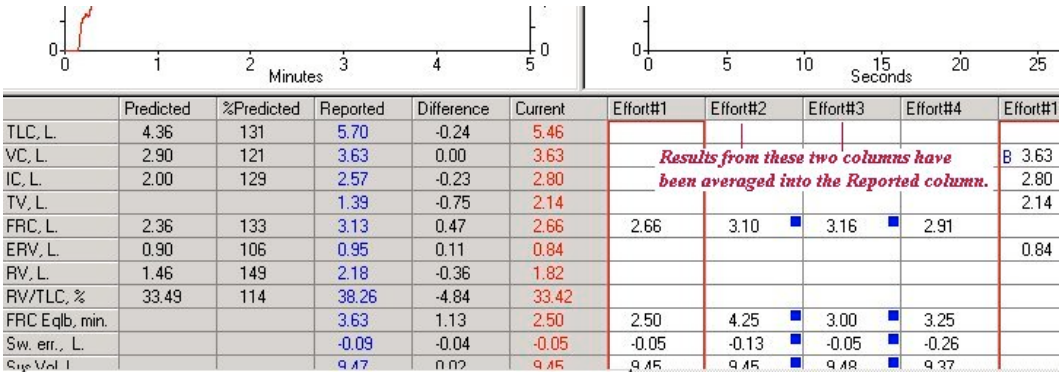
8. To take a set of data out of the Reported column, click on that column again and select Reported. Then click on Both, FRC, or SVC deepening on what portion you want removed from the Average.

9. Note that you will have a complete set of Lung Volumes in the Reported column once you have finished averaging.

10. The VC is different from the other parameters. When you right-click on the datasheet, one set of options is:

    **VC Best -** Directs the program to select the best VC, regardless of what is entered into the Reported column.
    **VC Average -** Has the VC be the result of averaging.

11. Select Save from Main Menu in order to save an Average.




| | Predicted | %Predicted | Reported | Difference | Current | Effort#1 | Effort#2 | Effort#3 | Effort#4 | Effort#1 |
|---|---|---|---|---|---|---|---|---|---|---|
| TLC, L. | 4.36 | 131 | 5.70 | -0.24 | 5.46 | | | | | |
| VC, L. | 2.90 | 121 | 3.63 | 0.00 | 3.63 | | | | | B 3.63 |
| IC, L. | 2.00 | 129 | 2.57 | -0.23 | 2.80 | | | | | 2.80 |
| TV, L. | | | 1.39 | -0.75 | 2.14 | | | | | 2.14 |
| FRC, L. | 2.36 | 133 | 3.13 | 0.47 | 2.66 | 2.66 | 3.10 | 3.16 | 2.91 | |
| ERV, L. | 0.90 | 106 | 0.95 | 0.11 | 0.84 | | | | | 0.84 |
| RV, L. | 1.46 | 149 | 2.18 | -0.36 | 1.82 | | | | | |
| RV/TLC, % | 33.49 | 114 | 38.26 | -4.84 | 33.42 | | | | | |
| FRC Eqlb, min. | | | 3.63 | 1.13 | 2.50 | 2.50 | 4.25 | 3.00 | 3.25 | |
| Sw. err., L. | | | -0.09 | -0.04 | -0.05 | -0.05 | -0.13 | -0.05 | -0.26 | |
| Sus Vol, L | | | 9.47 | 0.02 | 9.45 | 9.45 | 9.45 | 9.48 | 9.37 | |

Figure 5-21. Averaging Lung Volume Data

*Summary of Lung Volumes Options*

1. Following is a description of the Main FRC options, which are the ones displayed along the top of the FRC window:

**Start Test -** Initiates the test procedure.
**Choose SVC -** When you have completed more than one test, click on this option to select an effort with an SVC maneuver in it as the Current test. A drop-down menu with the effort numbers containing SVC maneuvers will display. When you select one of these, the corresponding effort in the datasheet will be highlighted in red and the corresponding graph will display.
**Choose FRC -** When you have completed more than one test, click on this option to select an effort with an FRC maneuver in it as the Current test. A drop-down menu with the effort numbers containing FRC maneuvers will display. When you select one of these, the corresponding effort in the datasheet will be highlighted in red and the corresponding graph will display.

**NOTE:**
You may also click on the column heading of the desired maneuver in the datasheet to select it.

**FRC Data/SVC Graph:** Click on this toggle button to display either the SVC graph or the detailed FRC data sheet for the upper right panel. Can also select these options using the right-click menus.
**Delete -** When you wish to delete an effort, make it the Current effort by selecting it in the Choose option or clicking on it. Then click on Delete.
**Save -** To save an effort just completed, click on Save.
**Reported -** Allows you to select and average data from the efforts conducted during the study to report as the final results. You may average just SVC data, just FRC data, or both.
**Undo -** Allows you to undo the last function completed, such as delete. This will only work if you have not selected Save since the last function.

*More Lung Volumes Options*

2. Use the right-click menus for other options. Point to either of four areas: the FRC graph, the SVC graph, the detailed FRC datasheet, or the general datasheet and right-click on the mouse. The following menus will display:

Right-Click on the FRC Graph:

**Copy FRC Graph** - Copies the graph to the clipboard and enables you to paste it where you wish.
**Print FRC Graph -** prints the graph
**Graph Scale = *n* -** shows a time scale on graph of 0 to the number of minutes you select. This is the time allowed for the FRC test

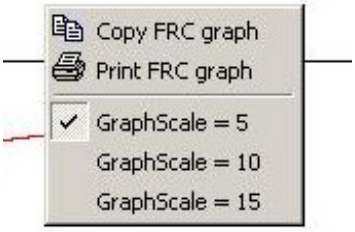



Figure 5-22. Right-Click Menu for the FRC Graph

**Right-Click on SVC Graph:**

**Copy SVC Graph -** Copies the graph to the clipboard and enables you to paste it where you wish.
**Print SVC Graph -** prints SVC graph.
**FRC Data -** Displays detailed FRC datasheet instead of SVC graph on right panel
**Graph Scale = *n*** - shows a time scale on graph of 0 to the number of seconds you select. This is the time allowed for the SVC test

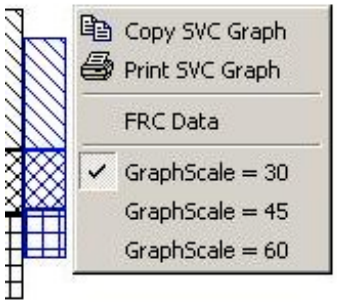



Figure 5-23. Right-Click Menu for the SVC Graph

**Right-click on Detailed FRC Datasheet:**

**Copy FRC Data -** Copies the data to the clipboard and enables you to paste it where you wish.
**Print FRC Data -** Prints the FRC Data
**SVC Graph -** Displays SVC graph instead of detailed FRC datasheet on right panel

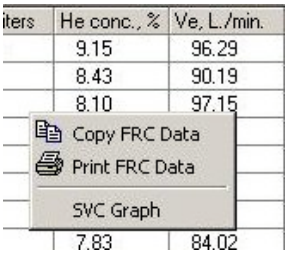



Figure 5-24. Right-Click Menu for the Detailed FRC Datasheet

**Right-click on Lung Volumes Datasheet**

**Copy Datasheet -** Copies the data to the clipboard and enables you to paste it where you wish.
**Print Datasheet** - prints the datasheet
**Report Both** - Reports data from both the FRC and SVC maneuvers on the datasheet.

**Report FRC -** Reports data from just the FRC portion of the efforts on the datasheet, even if SVC maneuvers were performed.

**Report SVC -** Reports data from just the SVC portion of the Lung Volumes test on the datasheet, even if FRC maneuvers were performed.

**VC = Best -** Reports the best Vital Capacity as determined by the program in the Reported column.

**VC = Avg. -** Reports the Vital Capacity averaged by the user in the Reported Column.

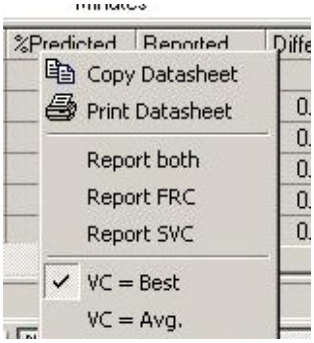



Figure 5-25. Right-Click Menu for the Lung Volumes Datasheet

**NOTE:**
Many of these options are also available on the Main Program Edit menu.

**Exiting the Lung Volumes Program**

1. When ready to leave the Lung Volumes program, be sure the desired Reported effort has been selected, as this is the one that will appear on the final Report.

2. Select Save to save the reported data.

3. Select the next desired Spirometry option.

**NOTE:**
Upon leaving the program, the screen will warn you if you have not saved data and give you an opportunity to do so.

## The Lung Volumes Test – Nitrogen Washout Method

1. The $N_2$ Washout Lung Volumes test combines the FRC and SVC maneuvers (conducted separately within the $N_2$ Washout test module) in order to measure a complete set of Lung Volumes.

2. The FRC (Functional Residual Capacity) is the volume of air remaining in the lungs at the end-expiratory position (after a normal, quiet exhalation). The FRC is calculated as the sum of the residual volume (RV) and the Expiratory Reserve Volume (ERV).

3. The SVC (Slow Vital Capacity) is the maximum amount of air expired from the point of maximum inspiration to maximum expiration (or vice-versa) without attention to speed. However, a maximal effort is still required to exhale completely to RV and inspire completely to total lung capacity (TLC).

### Preparing Equipment for the $N_2$ Washout Test

1. Refer to *Installation* in the Eagle hardware manual for more information about tubing and GEMtach (the Eagle pneumotach) connections.

2. After the basic connections have been made, attach a DC-2 filter to the patient port on the front of the GEMtach. The DC-2 is a low-resistance barrier filter designed for use in preventing patient droplet contamination of pulmonary equipment, thereby preventing patient cross-contamination. The DC-2 filter may be used alone. However, if the patient has a difficult time maintaining a lip seal on the DC-2 opening, a Collins Comfort Fit® Mouthpiece may be attached to the DC-2. A clean mouthpiece must be used for each patient.

3. Make sure the tank of $O_2$ is connected to the Eagle unit as described in the manual. To turn on the tank, turn the regulator stem counterclockwise with a tank wrench. To turn off the tank, turn the regulator stem clockwise.

### Lung Volumes Calibration

1. If a valid calibration file for each of the devices involved in $N_2$ Washout testing is not available, Lung Volumes testing cannot be conducted. Refer to *Section Four -- Calibration* for details.

2. Perform and save a valid calibration file for any of the devices that require valid calibration file:

*Barometric Pressure/Temperature Probe*
*Pneumotach*
*$N_2$ Gas Analyzer*

### Conducting the $N_2$ Washout Test

1. Before conducting the $N_2$ Washout test, make sure the desired patient and study are selected as described in Patient Testing. Click on the Pre/Post Rx button to the right of the patient cache to select Pre- or Post-drug testing.

2. Click on the GoTo button. Select *Lung Volumes ($N_2$)*.

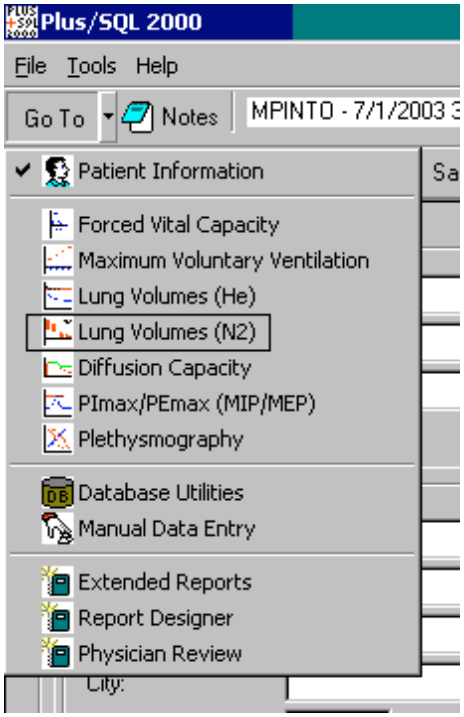



Figure 5-26. $N_2$ Washout Test on the GoTo Menu

3. A screen with three panes will display, as shown in the Figure below.

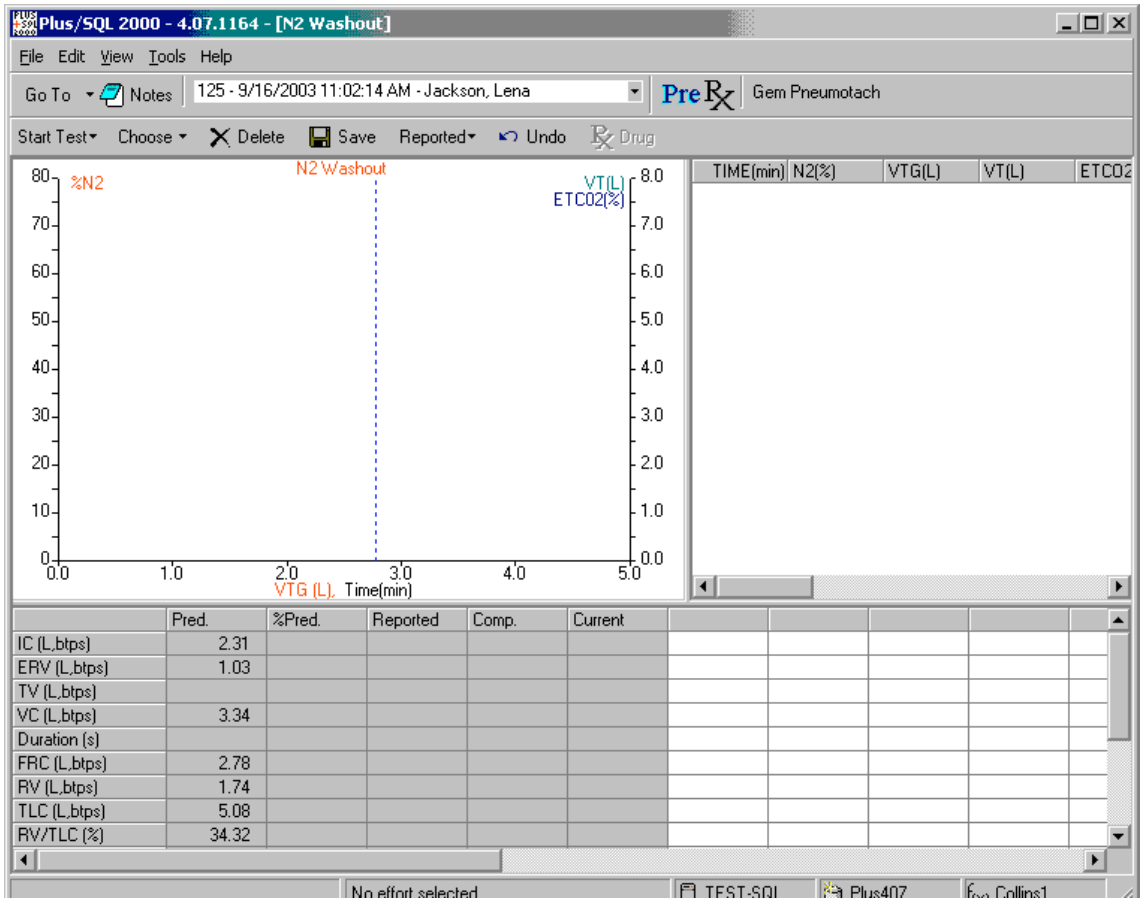



Figure 5-27. $N_2$ Washout Test Opening Screen

4. Counterclockwise from the left these screens display:

   The $N_2$ washout graph, which plots the $\%N_2$ (y-axis) vs. Time in minutes and VTG in Liters (both on the x-axis).
   The Gas Datasheet, which displays the $N_2$ data at the end of each breath.
   The Main Datasheet, which displays the calculated data for each completed effort.

**NOTE:**

If the Gas Datasheet does not display, right-click on the SVC or Tidal Volume graph in this space and select Gas Datasheet from the options menu.

5. You may change the size of a panel by pointing to a border and dragging it. For example, to expand the view of the table, point to the top table border and drag it upward. Drag this line downward to enlarge the graphs. You may also scroll the table horizontally to see more of it.

6. Select *Start Test*. The program will display a drop-down menu allowing you to choose between conducting the Lung Volumes and SVC test. Select Lung Volumes.

**NOTE:**

The FRC test and the SVC test are designed as uncoupled tests and are each performed as independent maneuvers. All FRC and SVC data is made available in Review so that you can select and combine the specific test efforts to be reported as lung volume data.

7. Select *Lung Volumes*. The test graphs will display as shown in the Figure below.

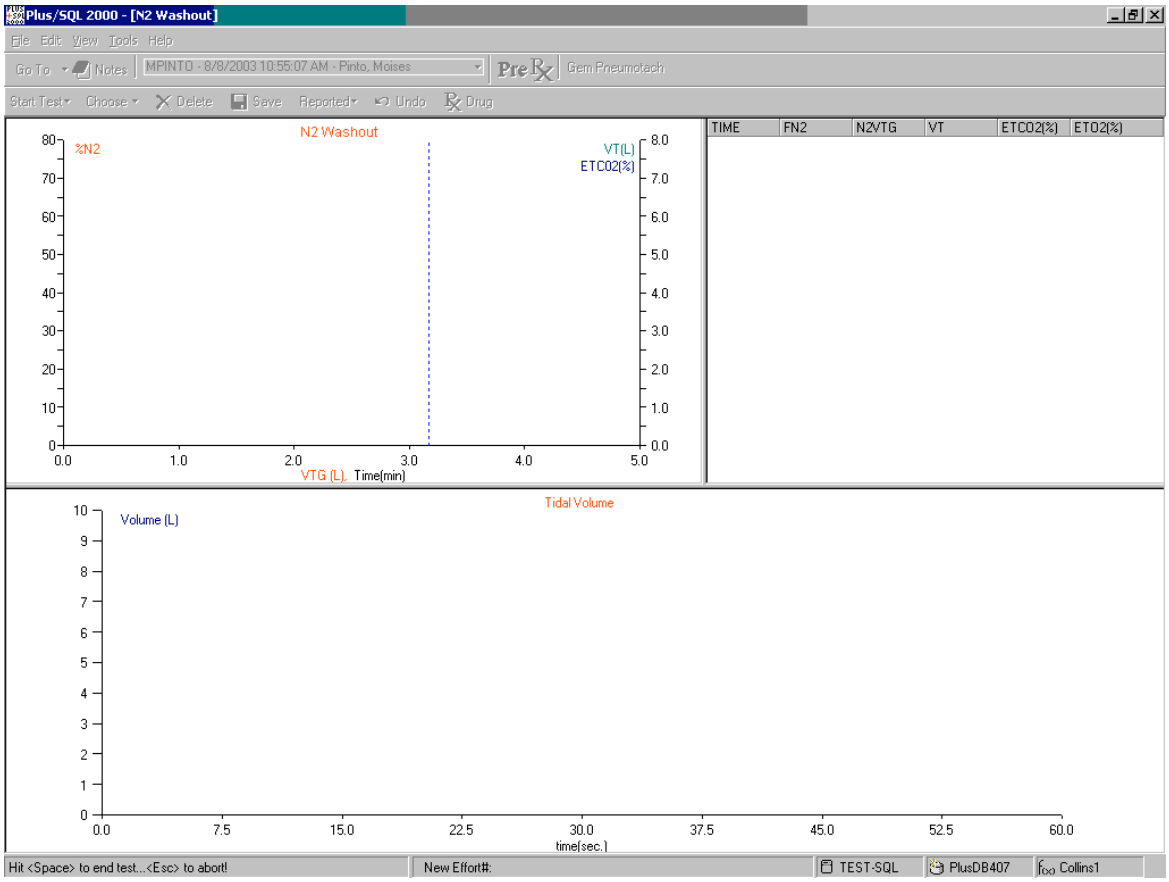



Figure 5-28. $N_2$ Washout Test Graphs

8. The program prompts you to ensure that there is no flow through the pneumotach. Make sure that there is no disturbance in the area of the pneumotach, such as breeze from a window, slamming doors, patient connected to the valve, valve movement, etc. Then click *OK*, or press the spacebar.

9. The system will conduct a zeroing procedure on the pneumotach, followed by the automatic test setup routine, which will display messages such as *Initializing Analyzers*, *Adjusting $CO_2$ offset*, *Checking Stability*, etc. No intervention is necessary during the automatic setup. Simply let the program run its course.

10. When finished with setup, the program will display the prompt:

*Press Spacebar when patient is connected to the mouthpiece and breathing normally.*

11. Explain the procedure to the patient, demonstrating if necessary.

12. Attach a noseclip. Connect the patient to the mouthpiece on the valve and direct him/her to breathe normally.

13. When the screen shows normal breathing, press the spacebar to initiate the test. From here, the switch-in procedure depends on whether you have selected True or False for Manual Switch-in on the $N_2$ Configuration tab. Each method is described below:

**Patient Switch-in**

Press the spacebar or click on *Start*. The system displays the patient's tidal breathing on the lower graph while establishing the end-tidal level. After the number of tidal breaths indicated in Configuration (see NOTE, below), a vertical line and a horizontal end-tidal line will display. After the vertical line displays and when the breath tracing has reached an end-tidal point, one of two events will occur depending on what was selected in Configure:

- If the $N_2$ washout test is configured with Manual Switch-in set to False, the program will automatically switch-in the patient at the proper time.

- If the test is configured with Manual Switch-in set to True, the operator must press the spacebar just as the patient has breathed out to his/her end-tidal level. If the spacebar was not pressed at exactly FRC, the system will establish a correction based on the Switch-in error.

**NOTE:**

The number of breaths indicated for Vt breaths in the $N_2$ Washout Configuration tab must be recorded in order to establish a baseline. The default is 6 breaths.

14. The $N_2$ washout graph will display the following tracings:

The $\%N_2$ – red
The calculated $N_2VTG$ – light green
Tidal Volume (VT) in Liters – dark green
End-tidal $CO_2$ ($\%EtCO_2$) – maroon (see *FRC Caution*, below)

15. The $\%N_2$ will decrease as $N_2$ is washed from the patient's system.
The vertical red lines on the $\%N_2$ tracing correspond to the end of each breath.
The $N_2VTG$ is the same as FRC if the patient was switched into the system at FRC.
The $EtCO_2$ tracing displays as a safety feature. See the Note below.

**$N_2$ WASHOUT CAUTION:**

Special care should be taken with subjects who have chronic obstructive pulmonary disease (COPD). In some people with COPD, chronic hypercapnia can blunt the normal blood carbon dioxide ($CO_2$) stimulus that maintains regular breathing. As a result, hypoxemia replaces hypercapnia as the physiologic factor that stimulates regular breathing. Prolonged breathing of 100% oxygen may increase the blood oxygen level in these subjects to a point where the stimulus to breathe is lost. Hypoventilation and acidosis may result. Since this risk in subjects with COPD is not predictable, all COPD subjects with chronic hypercapnia should be observed closely during the test for negative

response to the oxygen.* If oxygen-induced hypoventilation is documented by a persistent rise in the end-tidal $CO_2$ partial pressure ($PetCO_2$) during the test, the test should be terminated, the subject removed from the system and allowed to return to room air breathing. An alternative method of lung volume testing must be used for these subjects.

* From Pulmonary Function Testing and Cardiopulmonary Stress Testing, 2nd Ed. By Vincent C. Madama, Pg. 89.

16. At the end of each breath, $N_2$ is measured by the subtractive method, which uses the following formula:

$$\%N_2 = 1 - \%O_2 - \%CO_2$$

The program calculates the data and updates the $N_2$ washout tracing and gas data sheet at the end of each breath. The vertical lines on the $N_2$ Washout graph and the Time values in the gas datasheet correspond to the end of each breath.

17. In the lower half of the screen, the program will display continuous real-time readings in Volts versus Time:

Expired $O_2$ – top, green
Expired $CO_2$ – middle, blue
Flow- bottom, red

The readings are presented in Volts for the clarity of the graph. Rather than display scaled gas values, which differ significantly, this approach enables the needed information to be easily and clearly displayed.

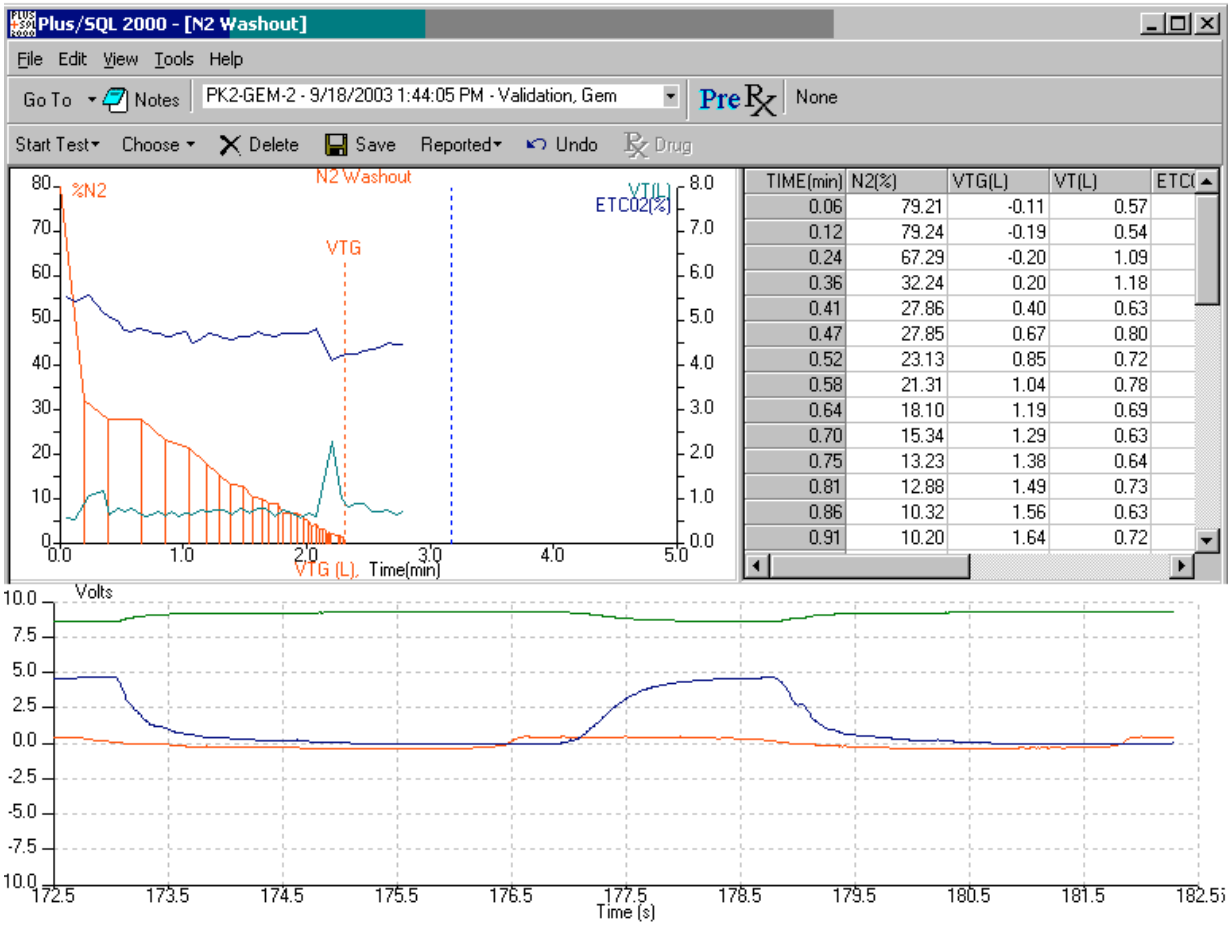



Figure 5-29. The $N_2$ Washout Test Screen

18. Continue having the patient breathe through the system until the $\%N_2$ falls below 1%-3%. Then press the spacebar to end the test.

    Collins uses 1% as the default end-of-test value. The end-of-test criterion is user-configurable on the $N_2$ washout tab under Tools/Configuration Editor. If the test is configured for automatic end-of-test termination, the following will occur: When the $\%N_2$ falls below the configured end-of-test point, a dialog message will display indicating that the end-of-test criteria have been met.

19. When the FRC test ends and final corrections have been applied, a vertical line will be drawn at the last breath to indicate the VTG, which is the same as FRC if the patient was switched into the system at exactly FRC. This line corresponds to the VTG in the last breath line on the gas datasheet. Proceed to *Review* to see how you may select a different VTG.

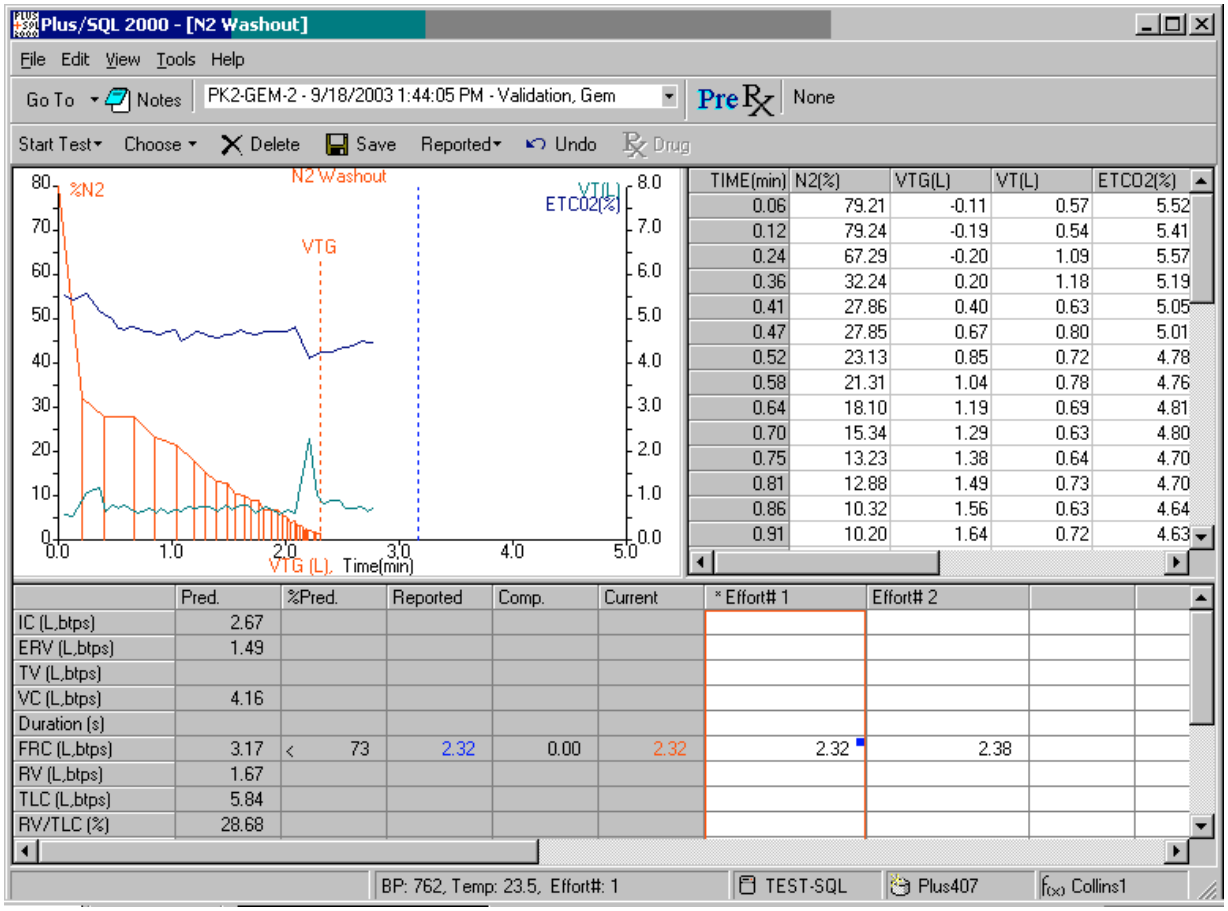



Figure 5-30. The Resulting $N_2$ Washout Tracing

*Conducting the SVC Test*

1. In order for the software to calculate a complete set of lung volumes, you must conduct an SVC test. From the test menu, click on *Start Test*, then *SVC*.

2. The graph for the SVC test will display. The program prompts you to ensure that there is no flow through the pneumotach. Make sure that there is no disturbance in the area of the pneumotach, such as breeze from a window, slamming doors, patient connected to the valve, valve movement, etc. Then press OK.

3. The system will conduct a zeroing procedure on the pneumotach, followed by the message:

   *Press Spacebar when patient is connected to the mouthpiece and breathing normally.*

4. Explain the procedure to the patient, demonstrating if necessary.

5. Attach a noseclip. Connect the patient to the mouthpiece on the valve and direct him/her to breathe normally.

6. When the patient is breathing tidally, press the spacebar. The program allows 30, 45, or 60 seconds in which to complete the maneuver, depending on what you selected for SVC options.

7. The program displays the patient's tidal breathing on the SVC graph. The number of breaths indicated for Vt breaths in $N_2$ Washout Configuration must be recorded in order to establish a baseline. The default is 6 breaths. When a baseline has been established, the program draws a vertical line on the tidal breath tracing as an indication that the SVC maneuver is to be performed and displays the following message:

   *Start SVC. Press Spacebar to end, Esc to abort.*

8. As soon as this message displays, direct the patient to inspire maximally to Total Lung Capacity (TLC) without attention to speed; the SVC tracing of the patient's breathing goes down. When TLC is reached, instruct the patient to expire maximally to Residual Volume (RV), again without attention to speed; the SVC tracing of the patient breathing rises. Verbally coax the patient during the maneuver to ensure a maximum effort. As the patient begins the next inspiration, press the spacebar to end the test.

**NOTE: Alternate SVC Method**

An alternate way to perform the SVC test is to breathe tidally, then when the vertical line displays, to first expire to RV (Residual Volume), then inspire to TLC (Total Lung Capacity), then expire to RV again, pressing the spacebar at the end of the maneuver.

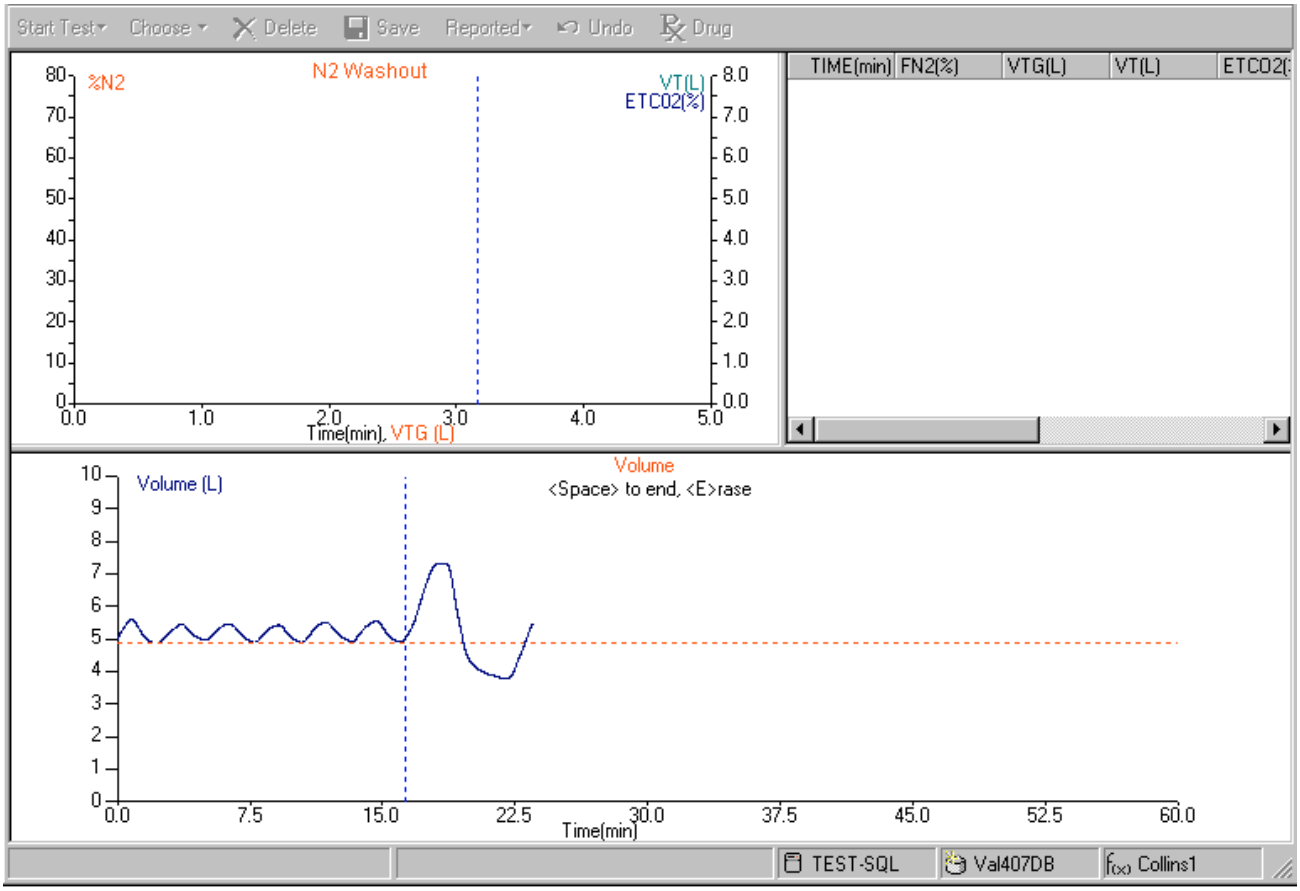



Figure 5-31. Conducting the SVC Test

9. When you have pressed the spacebar to end the test, the SVC tracing will display in the upper right pane.

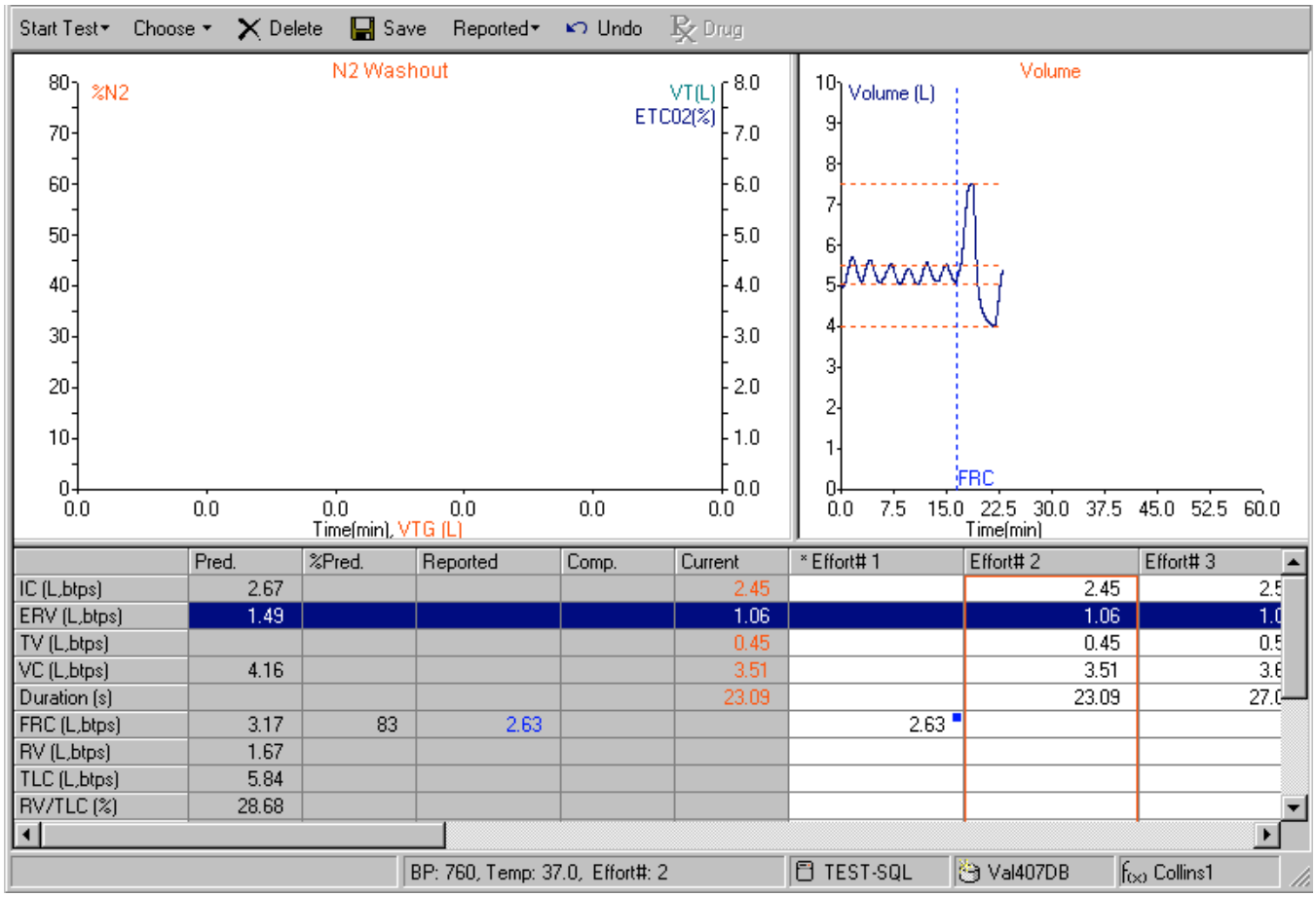



Figure 5-32. A Completed SVC Test Graph

10. Refer to *$N_2$ Washout Review* for an explanation of the resulting data and graphs.

11. You may accept 8 pre-drug tests for one study. This means that the number of Lung Volume tests plus the number of SVC tests must total no more than 8. The data for the 8 most recently performed tests will display in the datasheet. When you go to perform a ninth test, the program will prompt you to discard one effort in order to perform another. Refer to Lung Volumes Review for directions on discarding an effort.

12. You will be prompted to save Lung Volume data when you exit the test module. If you have not saved data before exiting, do so by click on the Save button.

**Lung Volumes Review**

1. At the completion of an FRC or SVC test, the program will display the resulting graph, FRC or SVC, in the appropriate pane and the data for that particular graph under the corresponding effort number in the datasheet.

2. You may review the data and graph of a different effort by clicking on the corresponding Effort # heading in the main Datasheet (lower pane). For example, to view Effort #2, click on the Effort #2 heading in the Datasheet to make Effort #2 current. The current effort will be highlighted in red.

**NOTE:**
You will not have a complete set of lung volume calculations until you enter at least 1 FRC and 1 SVC test into the Reported column. This is described further on under Averaging Data.

3. Depending on whether you select an SVC or an FVC effort, different graphs will display:

If you select an SVC test, the SVC graph for this test will display in the upper right pane.

If you select an FRC test, the FRC graph for this test will display in the upper left pane. Either the Gas datasheet or the Tidal Volume tracing will display in the upper right pane. To switch from Gas Datasheet to Tidal Volume tracing, right-click on the upper right pane and select *Tidal Graph* from the option menu.

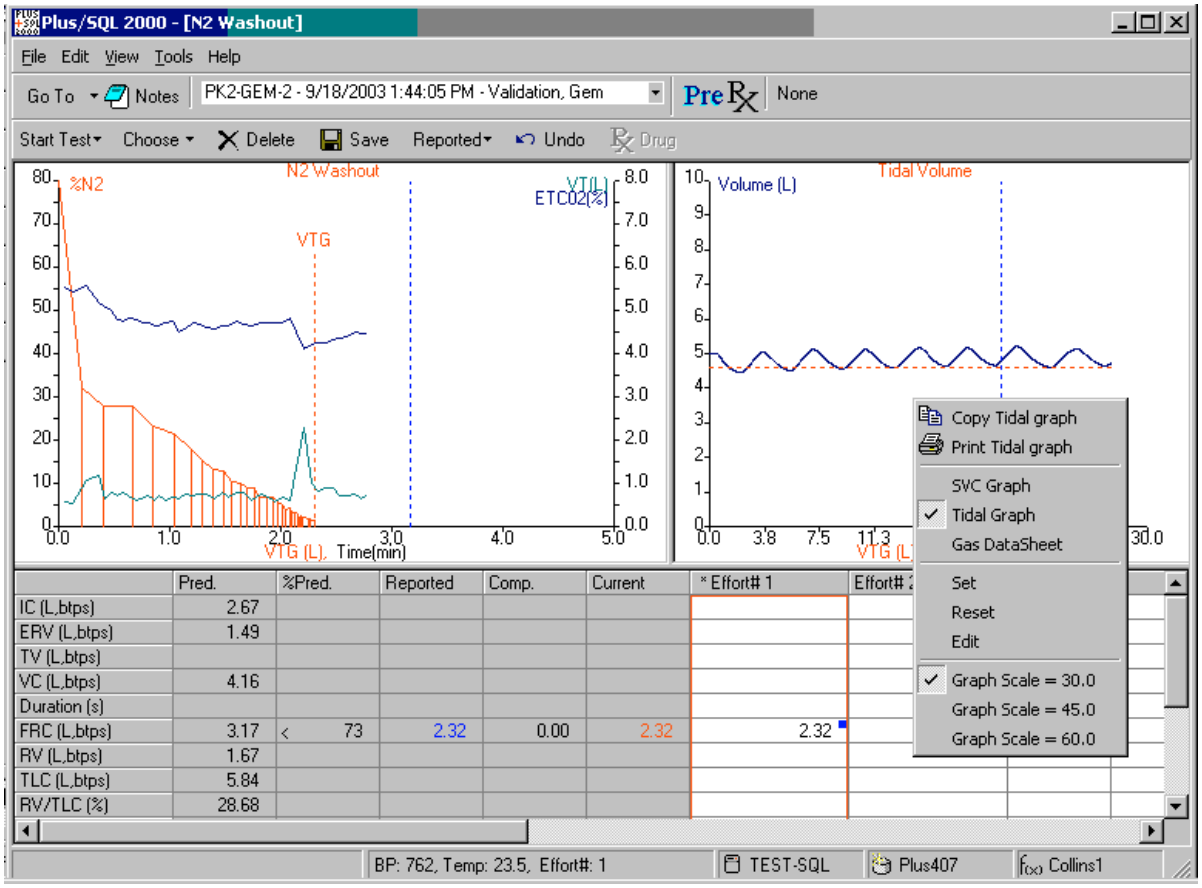



Figure 5-33. The Tidal Volume Graph and Right-Click Option Menu

4. The following instructions give more details about reviewing the data in each pane.

*Selecting the VTG*

1. At the end of the FRC test, a vertical line was drawn at the last breath to indicate the VTG, which is the same as FRC if the patient was switched into the system at exactly FRC. This line corresponds to the VTG in the last breath line on the gas datasheet.

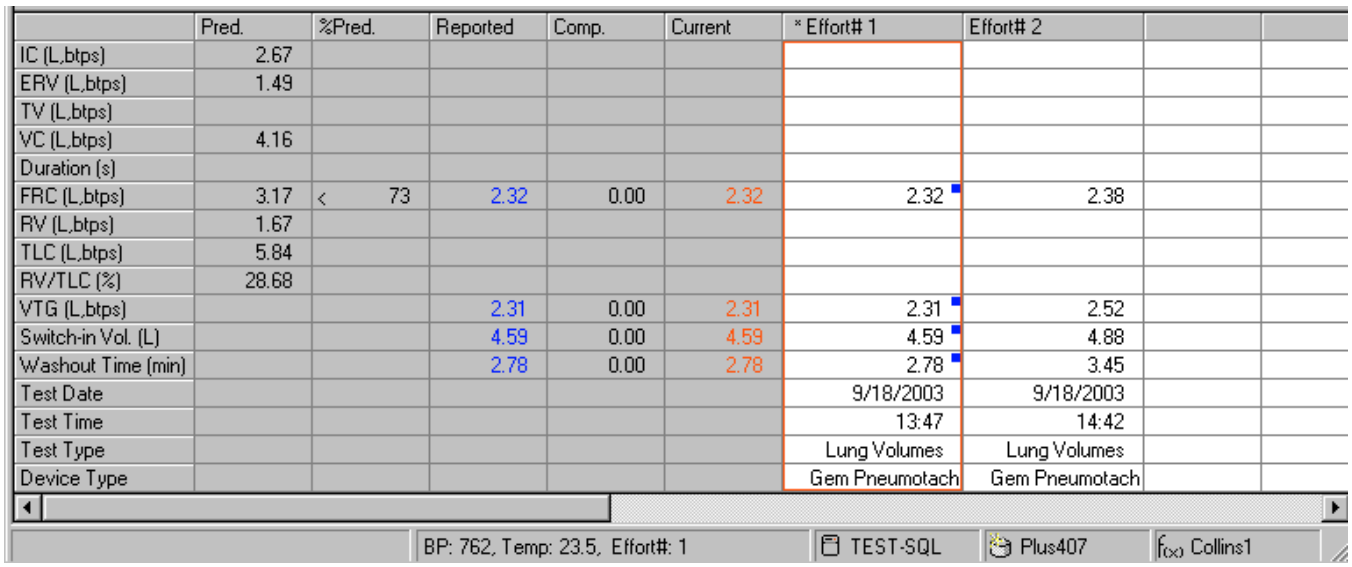
2. To select the VTG from another breath, click on the desired breath data line in the gas datasheet.

3. Right-click on the gas datasheet and then on *Select VTG* from the options menu. An asterisk will display on the newly selected line and the vertical VTG line in the FRC graph will move accordingly.

*Lung Volumes Datasheet*

1. The Lung Volumes Datasheet is located in the bottom pane of the 3-part FRC screen. You may scroll this screen up and down and from side to side to view more of it than fits in the window. You may also right-click on the datasheet and select *Full Datasheet* from the option menu in order to view the full data sheet on the screen.

2. The row headings are for Lung Volumes test parameters. The column headings are identified by effort number and by other categories described below.



| | Pred. | %Pred. | Reported | Comp. | Current | * Effort# 1 | Effort# 2 | |
|---|---|---|---|---|---|---|---|---|
| IC (L,btps) | 2.67 | | | | | | | |
| ERV (L,btps) | 1.49 | | | | | | | |
| TV (L,btps) | | | | | | | | |
| VC (L,btps) | 4.16 | | | | | | | |
| Duration (s) | | | | | | | | |
| FRC (L,btps) | 3.17 | < 73 | 2.32 | 0.00 | 2.32 | 2.32 | 2.38 | |
| RV (L,btps) | 1.67 | | | | | | | |
| TLC (L,btps) | 5.84 | | | | | | | |
| RV/TLC (%) | 28.68 | | | | | | | |
| VTG (L,btps) | | | 2.31 | 0.00 | 2.31 | 2.31 | 2.52 | |
| Switch-in Vol. (L) | | | 4.59 | 0.00 | 4.59 | 4.59 | 4.88 | |
| Washout Time (min) | | | 2.78 | 0.00 | 2.78 | 2.78 | 3.45 | |
| Test Date | | | | | | 9/18/2003 | 9/18/2003 | |
| Test Time | | | | | | 13:47 | 14:42 | |
| Test Type | | | | | | Lung Volumes | Lung Volumes | |
| Device Type | | | | | | Gem Pneumotach | Gem Pneumotach | |



Figure 5-34. The Lung Volumes Datasheet

**Predicted:** This column will contain the patient's predicted values, in other words, normal values. This gives the user a basis for comparing the Reported (best) test results.

**% Predicted:** For each parameter, the %Predicted column shows what percentage of the predicted value the Reported (best) value represents. For example, if the Predicted FRC is 2.78 liters and the Reported one is 3.05 Liters, the %Predicted column would show 91%.

**Effort # Columns:** These columns contain the results of the numerically labeled efforts. If one of these efforts is currently selected, it will also display in the Current column. If one of these efforts is the selected as the Reported (Best) effort, it will also display in the Reported column. Refer to Lung Volumes Reported Effort for more information about the Reported Column.

**NOTE:**

Effort numbers are continued from the previous effort number, even if that effort was deleted. Thus, if you delete Efforts number 1 and 2, the next effort will still be numbered 3 and will not start over again from 1.

**Current:** This column contains the effort that is currently selected and highlighted in red. The Current column itself is highlighted by red or by whatever color you chose in Configure. Click on the desired data column heading to make it current .

**Reported:** This column contains whichever efforts you choose to enter using the Reported command from the Main menu. It is highlighted in blue or whatever color you chose in Configure. You may enter single efforts into this column or enter in SVC and FRC data from different efforts. You may average more than one effort. In the actual effort columns, a value will have a blue box next to it if it is part of the Reported effort. Refer to Lung Volumes, Reported Effort and Averaging Results.

**Comp. (Comparison):** This column contains the numeric differences between the parameters in the Current and in the Reported column, for the sake of comparison. Note that the values will be zero if values from the Current column are the same as those in the Reported column.

3. Several of the row headings are explained below:

**Duration:** Refers to the time it took, in seconds, to complete the SVC test.

**Switch Error (L):** The "Switch-in Error" represents the baseline adjustment the system had to make if the patient was not switched into the system at exactly end tidal level (FRC).

**Test Time:** Refers to the time at which the test took place.

**Test Type:** Refers to whether the test was an FRC or SVC effort.

**Washout Time:** Refers to the time it took, in minutes, for the $N_2$ to be washed out of the patient's lungs.

**Device Type:** Refers to the testing instrument used, in this case, the GEM Pneumotach.

*Deleting an Effort*

1. In order to delete an effort, click on it to make it current. Then select *Delete* from the prompt line. In order to undelete, select *Undo* from the prompt line.

2. To save the data, click on *Save* from the Main Lung Volumes menu.

*The Gas Datasheet*

1. If the FRC gas datasheet does not display in the upper right pane, right-click on the pane and select *Gas Datasheet* from the options menu.

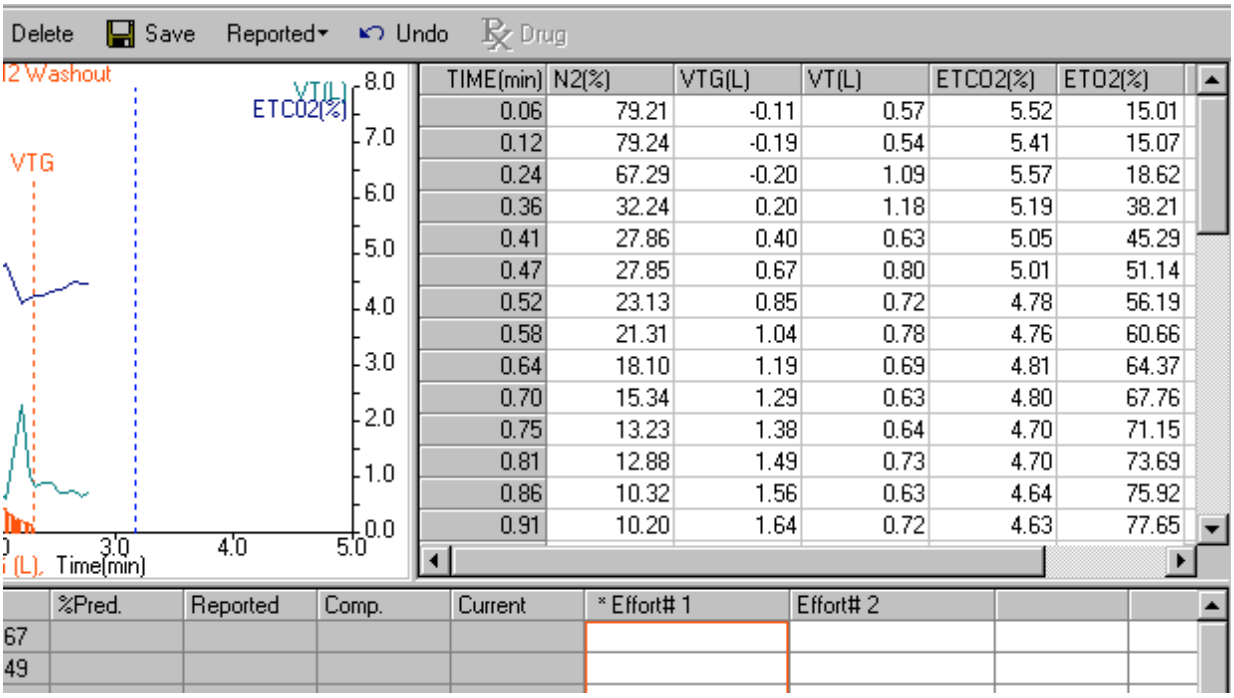



Figure 5-35. The $N_2$ Washout Gas Datasheet

2. The headings for gas datasheet are explained below.

**Time (min):** Represents the accumulated time at the end of each breath.
**FN2%:** The fractional concentration of $N_2$ at the end of each breath.
**VTG (L):** Volume of Thoracic gas, in liters, at the end of each breath. This value will be the same as FRC (functional residual capacity) if the patient was switch into the system at FRC.
**VT (L):** Tidal volume, the volume of air exhaled at the end of each breath.
**ETCO2(%):** The concentration of $CO_2$ expired at the end of each breath
**ETO2(%):** The concentration of $O_2$ expired at the end of each breath.

*Lung Volumes Graphs*

**FRC Graph**
This graph plots the $\%N_2$ in the patient's lungs versus the VTG in Liters. As the $N_2$ is washed out from the Patient's Lungs, the red tracing on this graph declines. Each vertical line in the $N_2$ washout tracing corresponds the end of a breath. The predicted VTG is designated by a vertical blue line. The actual VTG, which corresponds to the last breath, is indicated by another vertical line labeled VTG. If you wish to change the VTG breath, refer to *Changing the VTG*, above. The tidal volume (TV) and the end-tidal $CO_2$ ($ERCO_2\%$) on the other Yaxis are plotted against Time in minutes on the x-axis. Note that the labels and their respective tracings are color-coded.

**SVC Graph**
The SVC graph depicts a volume-time tracing containing dotted horizontal lines representing the various lung volumes and capacities. The broken vertical line intersects the point where the maximal maneuver was begun.

*Lung Volumes Reported Effort and Averaging Results*

1. Reported data is what you choose to report as the final data on the patient report. The Reported column contains the effort(s) you choose using the Reported command from the Main menu. It is highlighted in blue or whatever color you chose in Configure.

2. For the software to calculate a complete set of lung volumes, you must enter at least one FRC and one SVC effort into the Reported column. You may enter more than two efforts into the Reported column in order to average results. In the actual effort columns, a value will have a blue box next to it if it is part of the Reported effort.

3. To enter efforts into the Reported column for a complete set of lung volume calculations, conduct the following steps.

4. Click on the desired FRC column to make it current.

5. Click on Reported from the main options menu. The data entered into the Reported column will have a blue box next to it in the Current Column.

6. Repeat this procedure with an SVC effort. You will now have a complete set of Lung Volumes in the Reported Column.

7. To make the Reported column the result of averaging, repeat this procedure with as many efforts as you wish.

8. To take an effort out of the Reported column, click on that effort column again and select *Reported*.

10. Select *Save* from Main Menu in order to save an Average.

**NOTE:**
You may also use the *Report FRC Data* or *Report SVC Data* options from the datasheet right-click menu to enter efforts into the Reported column.

11. To indicate which FRC graph to use on the final report, select the desired effort, then *Report FRC Graph* from the right-click datasheet menu or the main options menu. Do the same for the desired SVC graph.

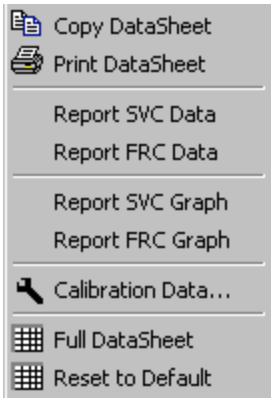



Figure 5-36. The $N_2$ Datasheet Right-Click Menu

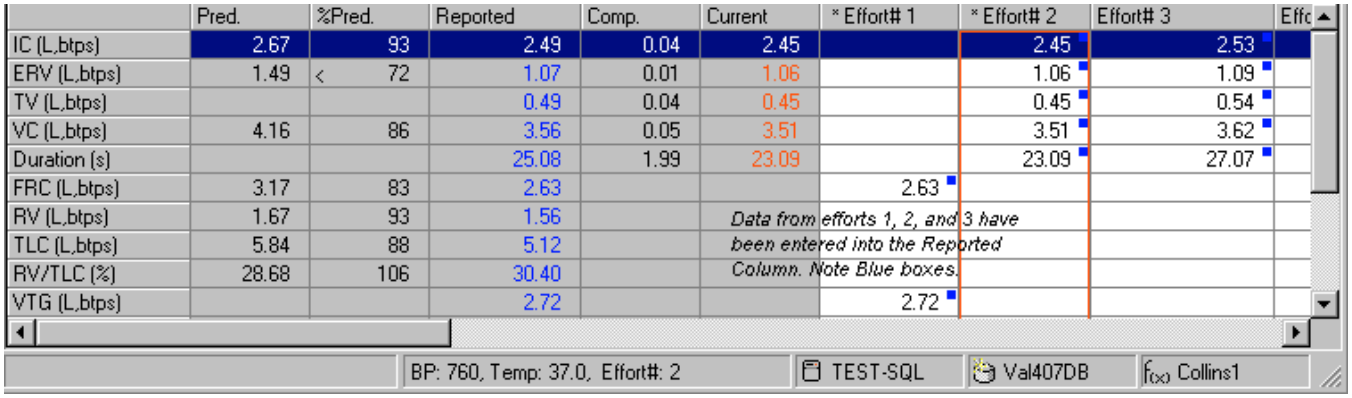

Pred.
%Pred.
Reported
Comp.
Current
* Effort# 1
* Effort# 2
Effort# 3
IC (L,btps) 2.67 93 2.49 0.04 2.45 2.45 2.53
ERV (L,btps) 1.49 < 72 1.07 0.01 1.06 1.06 1.09
TV (L,btps) 0.49 0.04 0.45 0.45 0.54
VC (L,btps) 4.16 86 3.56 0.05 3.51 3.51 3.62
Duration (s) 25.08 1.99 23.09 23.09 27.07
FRC (L,btps) 3.17 83 2.63 2.63
RV (L,btps) 1.67 93 1.56
TLC (L,btps) 5.84 88 5.12
RV/TLC (%) 28.68 106 30.40
VTG (L,btps) 2.72 2.72
Data from efforts 1, 2, and 3 have been entered into the Reported Column. Note Blue boxes.
BP: 760, Temp: 37.0, Effort#: 2
TEST-SQL
Val407DB
Collins1

Figure 5-37. Averaging Lung Volume Data

*Summary of Lung Volumes Options*

1. Following is a description of the Main FRC options, which are the ones displayed along the top of the FRC window:

**Start Test -** Initiates the test procedure.
**Choose –** Another way to select the current effort. When you select Current, a drop-down menu with the effort numbers will display. When you select one of these, the corresponding effort in the datasheet will be highlighted in red and the corresponding graph will display.
**Delete -** When you wish to delete an effort, make it the Current effort by selecting it in the Choose option or clicking on it. Then click on *Delete*.
**Save -** To save an effort just completed, click on Save.
**Reported -** Allows you to combine and average data from the efforts conducted during the study to report as the final results. You must average at least one FRC test and one SVC test in order for the software to calculate a full set of lung volumes.
**Undo -** Allows you to undo the last function completed, such as delete. This will only work if you have not selected Save since the last function.

*More Lung Volumes Options*

1. Each screen display has its own right-click option menu. Right-click on either the FRC tracing, Main Datasheet, SVC tracing, tidal volume tracing or gas datasheet to view these options, which are described below.

Right-Click on the FRC Graph:

**Copy $N_2$FRC Graph** - Copies the graph to the clipboard and enables you to paste it where you wish.
**Print $N_2$FRC Graph -** prints the graph
**Graph Scale = *n* –** Changes the graph time scale, in minutes. This is the time allowed for the FRC test

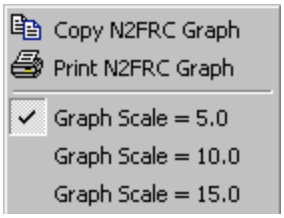



Figure 5-38. Right-Click Menu for the FRC Graph

Right-Click on SVC Graph:

**Copy SVC Graph -** Copies the graph to the clipboard and enables you to paste it where you wish.
**Print SVC Graph -** prints SVC graph.

**SVC Graph/Tidal Graph/Gas Datasheet –** Checking one of these allows the display to change to the designated graph or datasheet.
**Graph Scale = *n*** – Allows you to change the number of seconds permitted for the SVC test.
**Set/Reset/Edit** – Allows you to reposition the horizontal lines on the SVC graph. Click on *Edit* and hold the pointer over the desired line. A cursor will appear on the line. Hold down left mouse key to drag the cursor to another position. Then click on *Set*. The line will appear in the new position. To move it back to the previous position, click on *Reset*.

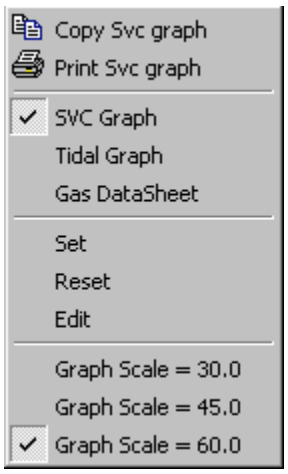



Figure 5-39. Right-Click Menu for the SVC Graph

Right-click on Gas Datasheet:

**Copy FRC Data -** Copies the data to the clipboard and enables you to paste it where you wish.
**Print FRC Data -** Prints the FRC Data
**SVC Graph/ Tidal Graph/Gas Datasheet –** Allows you to switch to another display for this panel.
**Select VTG –** Allows you to select a breath other than the last breath to designate as the VTG. An asterisk will appear on the line of the newly selected breath on the datasheet. The vertical VTG line will move to the corresponding point on the FRC graph.

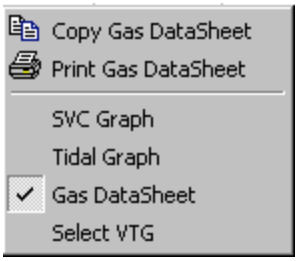



Figure 5-40. Right-Click Menu for the Detailed FRC Datasheet

Right-click on Main Datasheet:

**Copy Datasheet -** Copies the data to the clipboard and enables you to paste it where you wish.
**Print Datasheet** - prints the datasheet
**Report SVC** – Enters data from the currently selected SVC test into the Reported column.
**Report FRC –** Enters data from the currently selected FRC test into the Reported column.
**Report SVC Graph** – Designates the graph from the currently selected SVC test as the one to appear in the Final Report.
**Report FRC Graph –** Designates the graph from the currently selected FRC test as the one to appear in the Final Report.
**Calibration Data** – Displays the calibration data for the $N_2$ Washout test.
**Full Datasheet** – Displays the contents of the datasheet in a single view.
**Reset to Default** – Displays the contents of the datasheet in partial view, with scroll bars to allow you to view more.

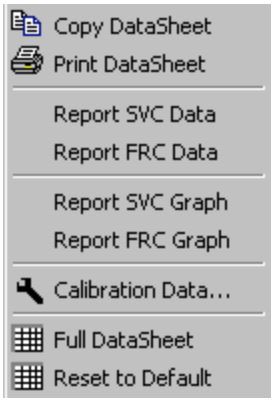



Figure 5-41. Right-Click Menu for the Lung Volumes Datasheet

**Exiting the Lung Volumes Program**

1. When ready to leave the Lung Volumes program, be sure the desired Reported effort and graphs have been selected, as these are the ones that will appear on the final Report.

2. Select the next desired Spirometry option.

3. Data and graphs for each effort are saved automatically as soon as that effort is completed. When leaving a test module, the user-selected reported data and graph are saved automatically. When returning to the module to review data after the testing session, you can override reported and graphical data selected at test time. Click the Save icon to update the database to your new selection.

**NOTE:**
Upon leaving the program, the screen will prompt you to select the data to be reported, if the program is unable to automatically select the Reported data.

## The Diffusion Capacity Test

1. The Single Breath Diffusion Capacity test (DSB) is defined as the volume of gas (in milliliters STPD) that can diffuse across the alveolar-capillary membrane per minute per mmHg of mean pressure gradient. This volume is derived using the lung volume from a single breath dilution of an inert tracer gas (i.e., He, $CH_4$).

2. With the Collins microGA, sampling is done at-the-mouth, in real-time, rather than conducting the sample in a bag after collection has been completed, as with conventional diffusion.

3. A variety of terminology is used in referring to the Single Breath Diffusion Test. DLCO, DCO, SBD and DLSB are frequently used in addition to DSB. These terms all refer to the same test. PLUS software uses DCO for the diffusion value calculated using the alveolar volume (VARB) from a previously performed helium dilution lung volume test (RB denotes rebreathing). The diffusion value calculated using the VARB obtained from CH4 dilution during the 10-second breath hold time of the single breath maneuver is reported as the DSB (SB denotes single breath).

4. In the United Kingdom, the Diffusion Capacity is referred to as the Transfer Factor. The parameters Dsb and DCO are referred to as Tsb and TLCO. Whereas the Dsb and DCO values are reported in ml/mm/mmHg, the Tsb and TLCO values are reported in mmol/min/kPa (Systeme Internationale Units). PLUS software has a European English version that reports Transfer Factor units.

5. During the DSB test, the PLUS program adjusts the Volume Inspired (VINSP) to correct for instrument deadspace by subtracting the installed system deadspace from this value. The installed system deadspace would include the deadspace for the valve and small mouthpiece adapter (15 ml) plus any additions for the large mouthpiece adapter (22 ml) and the DC-2 filter (89 ml). For more details, refer to the Dsb Configuration.

6. (2.2 * body weight in kg)/1000 = anatomical deadspace in liters. This volume is expressed at ATPD. Thus, it is corrected to BTPS before subtracting it from BTPS volumes.

7. With the Collins dry-seal spirometer, the volume inspired is corrected from ATPD to BTPS conditions.

8. DSBhb and DCOhb indicate diffusion values adjusted for hemoglobin, COHb, or both.

9. The standards applied in the DSB test are those of the American Thoracic Society. Collins therefore employs the Jones-Meade method of measuring Breath-hold Time (BHT). With this method, the BHT is measured from one third of the way through inspiration to halfway through the sample collection.

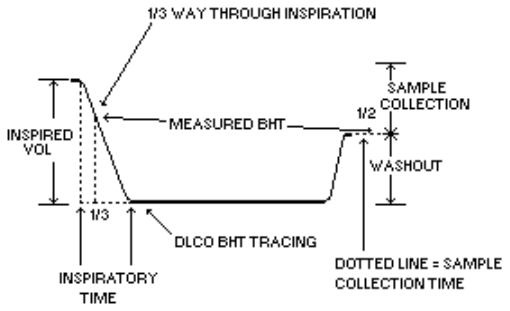



Figure 5-42. The Jones-Meade Method of Measuring Breath-hold Time

**DSB Preparing Equipment for Testing**

1. Refer to Preparing the System for PFT Testing in the CPL Hardware section for more information about tubing connections between the balloon valve and the CPL, pneumotach connections, etc. In addition, the Nafion tubing must be connected to the proper fitting on the balloon valve and to the Alveolar Sample Port on the CPL.

2. After the basic connections have been made, attach a DC-2 filter to the patient port on the front of the Balloon Valve. The DC-2 is a low-resistance barrier filter designed for use in preventing patient droplet contamination of pulmonary equipment, thereby preventing patient cross-contamination. The DC-2 filter may be used alone. However, if the patient has a difficult time maintaining a lip seal on the DC-2 opening, a mouthpiece may be attached to the DC-2.

3. Make sure that the tank of $O_2$ for operating the Balloon Valve is connected to the appropriate inlet on the lower rear panel of the CPL (the blue one) and that it is turned on. To do so, turn the regulator stem counterclockwise with a tank wrench. To turn the tank off, turn the regulator stem clockwise. Do the same for the DL gas tank (yellow inlet). Refer to Preparing the Gas Tanks.

**DSB Calibration**

1. If a valid calibration file for each of the devices involved in Diffusion is not available, diffusion testing cannot be conducted. Refer to Section Four -- Calibration.

2. Perform and save a valid calibration for any of the devices that require valid calibration file:

*Barometric Pressure/Temperature Probe*
*Pneumotach*
*Spirometer*
*Gas Analyzers*

**Conducting the DSB Test**

1. Before conducting the Dsb test, make sure the desired patient and study are selected as described in Patient Testing. Click on the button to the right of the patient name to select Pre- or Post-drug testing. If performing Post-drug testing, refer to Post-Drug Testing.

2. Refer to Dsb Configuration for any changes you may wish to make regarding breathhold time, washout volume, corrections, etc.

3. Refer to Dsb Options for a description of options in the right-click menus, such as graph scaling, types of graphs to display, corrections, and for a description of the main menu options.

4. To select the Dsb test, click on Go To from the Main Menu, followed by Diffusion Capacity.

5. A screen with three panes will display the following:

**DL graph,** with predicted lines drawn for RV and TLC. The y-axis represents the volume in liters and the x-axis represents the time in seconds

**Washout graph.** The y-axis represents the percentage of gasses in the sample and the x-axis represents the time in seconds.

**Dsb Datasheet.**

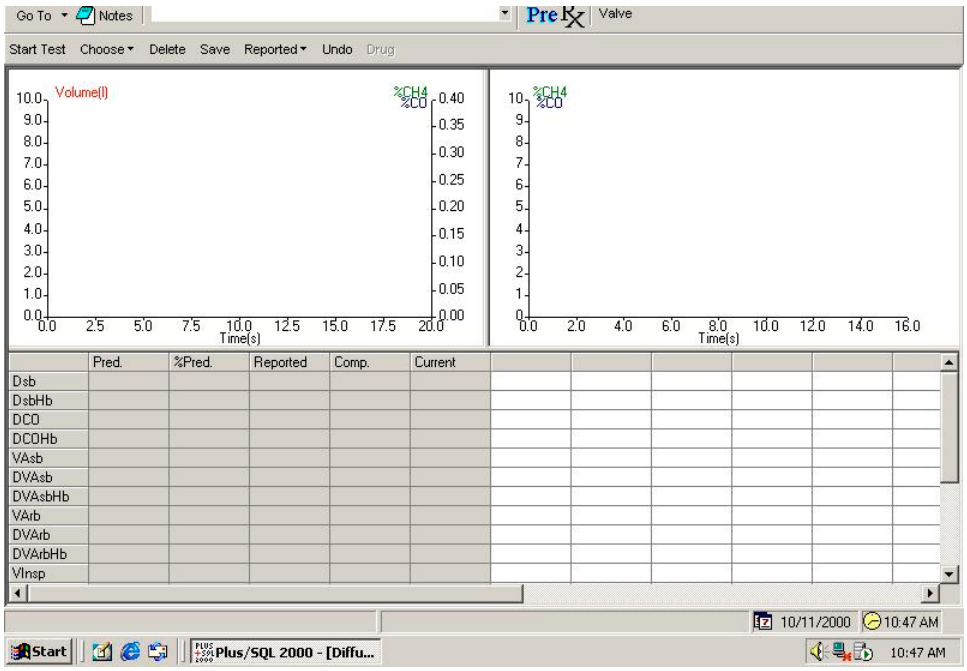



Figure 5-43. The Opening Dsb Screen

5. The following prompt line also displays:

*Start Test / Choose / Delete / Save / Reported / Undo*

6. Refer to Dsb Options for a description of each of these options. The options that are grayed-out are for post-drug testing.

7. You may change the size of the panels by pointing to a border and dragging it. For example, to expand the view of the table, point to the top table border and drag it upward. Drag this line downward to enlarge the graphs. You may also scroll the table horizontally to see more of it.

8. Be sure to turn on the $O_2$ and DL tanks.

9. In the following instructions, subsequent program messages will be written in italics.

10. Select Start Test.

11. You will get a series of messages as the program sets up the system for the Dsb test. The offsets will be adjusted, the sample line will be purged, and the spirometer will flush and fill several times in succession.

12. At the end of the adjustment routine, the program will display the Dsb Expiration graph, along with the following message:

    *Press Spacebar when patient is connected to the mouthpiece and breathing normally.*

13. Explain the procedure to the patient, demonstrating if necessary.

14. Attach a noseclip.

15. Connect the patient to the mouthpiece on the valve and direct him/her to breathe normally. Then press the spacebar.

16. The first graph to display will be the Dsb Expiration graph, which helps you visualize when the patient is at RV. A tracing of the patient's tidal breathing will display. A black line will be drawn at his end-expiration point.

17. When the patient is comfortable at the mouthpiece (usually after several breaths), direct him to exhale maximally to Residual Volume (RV). Verbally coax the patient during testing to ensure a maximum effort. Note that the black line drops to correspond with the diminishing volume. When the line will drop no further, the patient is at RV.

18. At RV, press the spacebar and immediately tell the patient to inspire maximally and rapidly, then to hold his breath for the configured breath-holding period, the end of which is represented on the graph by a vertical line.

19. As soon as you press the spacebar, the DL Maneuver graph will display. It will show the gas distribution tracing along with the volume tracing.

20. On the volume tracing are two dotted lines. One represents 90% and the other, 100% of the patient's maximum inspiratory point (value).

    The maximal inspiratory point is taken from the larger of the reported FVC or SVC saved for this patient; if these don't exist, the patient's predicted FVC is used.

    The area between the two dotted lines represents a target area for the inspiratory portion of the Diffusion test. The patient should be able to inspire enough to bring the tracing within these two dotted lines.

21. The volume tracing depicts the inspiratory maneuver as an ascending red line; when maximum inspiratory capacity has been reached, this red line becomes horizontal.

**NOTE:**

If you notice from the volume tracing that the patient is exhaling during the breath-holding period, press V to close the valve and thus hold the patient at the current lung volume. Pressing V again will open the valve.

If the mouth valve is closed during breath hold, it will open to allow washout at the end of the configured breath hold time.

22. The $\%CH_4$ and %CO tracings will occur simultaneously with the volume-time tracing.

23. When the breath-holding time is over (when the volume-time tracing reaches the vertical line), direct the patient to exhale forcefully and maximally through the mouthpiece. The final maximal expiration is shown on the volume-time tracing as a descending line.

24. Have the patient continue to exhale until a sufficient phase 3 of gasses has been collected. Then press the spacebar to end the test or allow it to run until the end, at which point it will end automatically.

25. The program will return to the opening screen, which will display tracings and data. At the completion of each Dsb maneuver, three parameters for Effort Quality will display in a line on the DL graph to indicate the quality of the effort.

*SOT - Start-of-Test*

*BHT - Breath-Hold-Time*
*EOT - End-of-Test*

26. A plus sign next to one of these parameters indicates that the effort in this regard was satisfactory; a minus indicates that it was unsatisfactory. If all criteria are within limits, the line of parameters will display in green. If one or more of the criteria is out of range, the line will display in red.

27. Refer to *Dsb Review* for a further description of the graphs and datasheet.

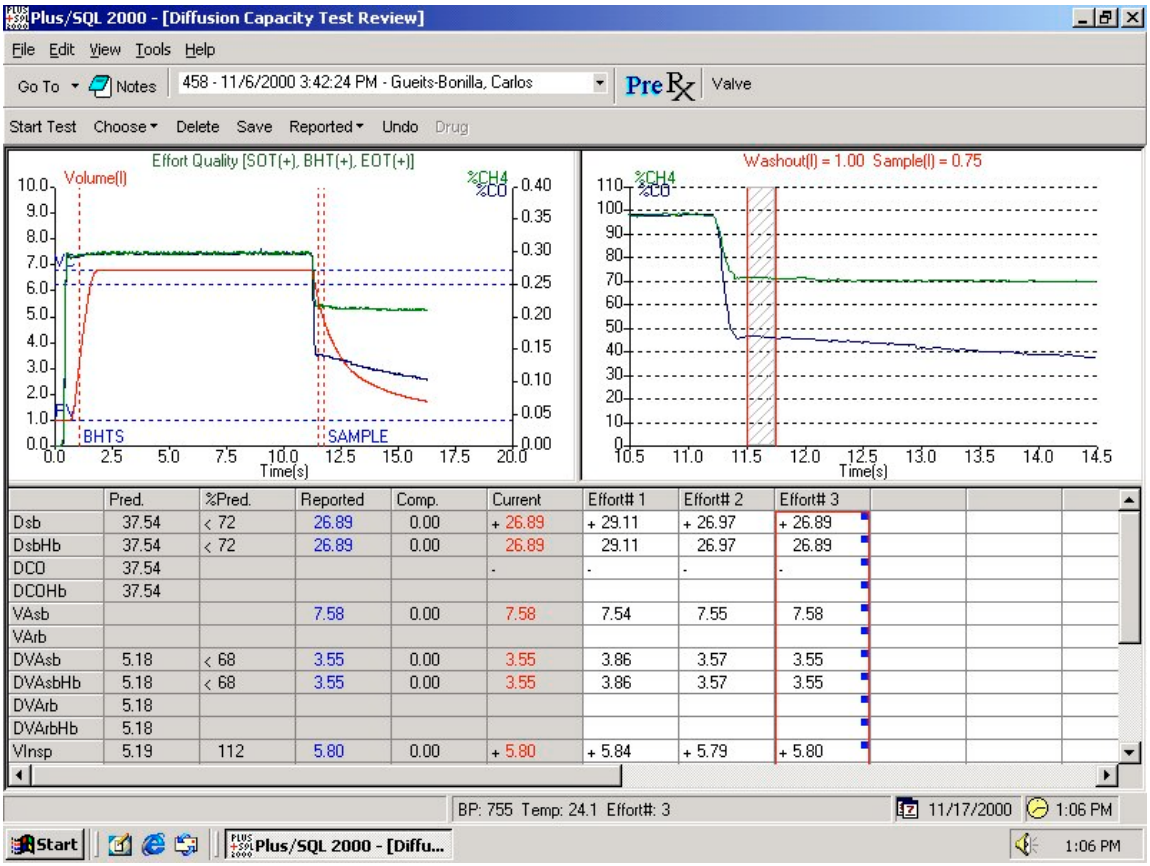

Plus/SQL 2000 - [Diffusion Capacity Test Review]
File Edit View Tools Help
Go To Notes
458 - 11/6/2000 3:42:24 PM - Gueits-Bonilla, Carlos
Pre Rx Valve
Start Test Choose Delete Save Reported Undo Drug
Effort Quality [SOT(+), BHT(+), EOT(+)]
Volume(l)
%CH4
%CO
VC
FV
BHTS
SAMPLE
Time(s)
Washout(l) = 1.00 Sample(l) = 0.75
%CH4
%CO
Time(s)
Pred. %Pred. Reported Comp. Current Effort# 1 Effort# 2 Effort# 3
Dsb 37.54 < 72 26.89 0.00 + 26.89 + 29.11 + 26.97 + 26.89
DsbHb 37.54 < 72 26.89 0.00 26.89 29.11 26.97 26.89
DCO 37.54 - - - -
DCOHb 37.54
VAsb 7.58 0.00 7.58 7.54 7.55 7.58
VArb
DVAsb 5.18 < 68 3.55 0.00 3.55 3.86 3.57 3.55
DVAsbHb 5.18 < 68 3.55 0.00 3.55 3.86 3.57 3.55
DVArb 5.18
DVArbHb 5.18
VInsp 5.19 112 5.80 0.00 + 5.80 + 5.84 + 5.79 + 5.80
BP: 755 Temp: 24.1 Effort#: 3
11/17/2000 1:06 PM
Start
Plus/SQL 2000 - [Diffu...
1:06 PM

Figure 5-44. A Completed Dsb Test Screen

28. Repeat the Dsb test until two results check to within 5% of each other. Allow sufficient time between Dsb maneuvers for residual $CH_4$ to be expired from the lungs.

**DSB Review**

1. At the completion of the test, the following can be observed:
   The **DL** and the **Washout** graphs will display. You may alter points on the Washout Graph. See Dsb Test Graphs.
   The tabular data will display on the **Datasheet.**

2. In order to delete an effort, click on it to make it current. Then select Delete from the prompt line. In order to undelete, select Undo from the prompt line.

3. Click on Reported in order to select an effort or average efforts to appear on the final report.

4. To save the data, click on Save from the Main Dsb menu.

5. If you have more than one Dsb, to select an effort as the Current one, click on Choose or on the heading in the datasheet.

The effort will be highlighted in red in the tabular column and will display on the graph.

6. Each of the above options is described in detail under its own heading.

*DSB Datasheet*

1. The Dsb datasheet is located in the bottom pane of the 3-part Dsb screen. You may scroll this screen up and down and from side to side to view more of it than fits in the window. You may also move the border between the datasheet and the graph in order to expand the view (click on the border and drag).
2. The row headings are for Dsb test parameters. The column headings are identified by effort and by the categories described in the other test programs. The only difference is the reported, column, for which you may enter a single effort or average more than one effort. Refer to Dsb Reported Effort and Averaging Results.

*Discarding a Dsb Effort*

1. The program allows you to save 8 Dsb efforts per study. When you have saved 9, the program displays the following message:

   *Maximum number of test efforts are exceeded. Must delete an effort to test.*

2. To discard an effort, simply highlight it with the mouse and click on Delete. You may undo the delete clicking on Undo.

*DSB Test Graphs*

The DL Graph

1. The DL graph displays tracings of the DSB maneuver (red) and of gas distribution for %CH4 (green) and %CO. The three vertical lines from left to right represent:

   Start of Breath-Hold Time (BHTS)
   Beginning of Sample period
   End of Sample Period

2. The three horizontal lines from top to bottom represent:

   TLC - Total Lung Capacity
   90% of Total Lung Capacity
   RV - Residual Volume

The Disability Graph

3. To display the Disability graph instead of the DL graph, right-click on the DL graph and select Disability graph. The Disability Graph is a version of the DL graph that provides a smaller scale with more detail, which is acceptable for Social Security Disability evaluation and which satisfies ATS recommendations for conducting hand calculations.

The Washout Graph

4. The washout graph displays the gas distribution tracings during the Washout and Sample periods of the Dsb test.

5. Two values are listed above the Washout graph: the Washout Volume and the Sample Volume, both in liters. These are the values specified in Dsb Configuration.

6. The sample period is represented by two vertical lines with shading between them. The portion of the tracing from the end of breathhold time to the beginning of the sample period represents the washout phase.

7. You can use the right-click options on the Washout graph to move the beginning and ending lines of the sample period or

to move the time scale of the graph.

8. The **Move Begin** option is used to adjust the washout volume. The sample volume (the volume enclosed within the lines) will remain at the current value.

   To move the Begin Sample line, select this option from the right-click menu, click on the Begin line and move it accordingly. Press Save if you want to save these changes.

**NOTE:**

An example of when you would use the Move Begin option: Persons with a Vital Capacity of less than 2 Liters sometimes will not have completely washed out by the time the program begins the sampling. Therefore, you may wish to alter the beginning of the Sample period by moving the Begin line to the right.

9. The **Move End** option is used to adjust the sample volume. The Begin Sample line will not move.

   To move the End-Sample line, select this option from the right-click menu, click on the End line and move it accordingly. Press *Save* if you want to save these changes.

10. To reset the Begin and End lines to their original positions after having moved them, select **the Reset Lines** option.

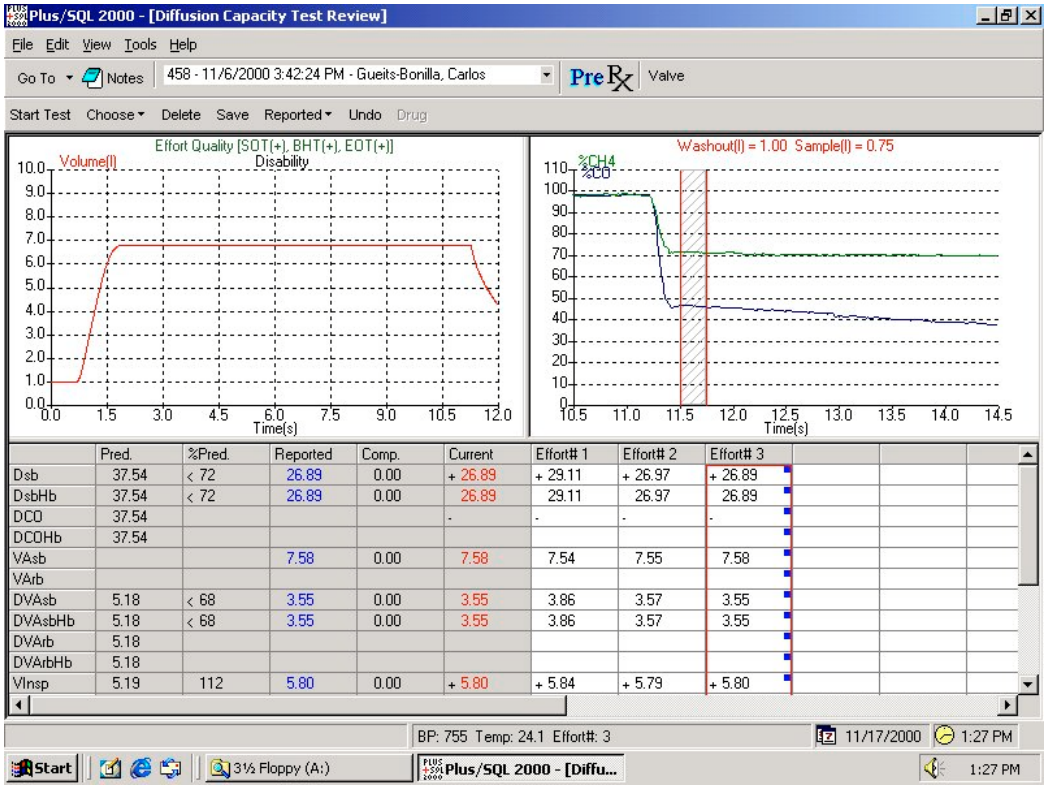

Plus/SQL 2000 - [Diffusion Capacity Test Review]
File Edit View Tools Help
Go To Notes
458 - 11/6/2000 3:42:24 PM - Gueits-Bonilla, Carlos
Pre Rx Valve
Start Test Choose Delete Save Reported Undo Drug
Effort Quality [SOT(+), BHT(+), EOT(+)]
Volume(l)
Disability
Time(s)
Washout(l) = 1.00 Sample(l) = 0.75
%CH4
%CO
Time(s)
Pred. %Pred. Reported Comp. Current Effort# 1 Effort# 2 Effort# 3
Dsb 37.54 < 72 26.89 0.00 + 26.89 + 29.11 + 26.97 + 26.89
DsbHb 37.54 < 72 26.89 0.00 26.89 29.11 26.97 26.89
DCO 37.54 - - -
DCOHb 37.54
VAsb 7.58 0.00 7.58 7.54 7.55 7.58
VArb
DVAsb 5.18 < 68 3.55 0.00 3.55 3.86 3.57 3.55
DVAsbHb 5.18 < 68 3.55 0.00 3.55 3.86 3.57 3.55
DVArb 5.18
DVArbHb 5.18
VInsp 5.19 112 5.80 0.00 + 5.80 + 5.84 + 5.79 + 5.80
BP: 755 Temp: 24.1 Effort#: 3
11/17/2000 1:27 PM
Start
3½ Floppy (A:)
Plus/SQL 2000 - [Diffu...
1:27 PM

Figure 5-45. The Dsb Disability and Washout Graphs

**NOTES:**

In the case where the patient expired less than the sum of washout plus sample volume, the Begin-Sample line will be set at washout and the End-Sample line will be positioned to collect as much sample as possible.

A sample size of 0.0L would imply that no gas sample was taken. Therefore this is not allowed when using these options. It is important to keep this in mind when trying to manually set the sample collection for an effort.

11. The **Move Time** option allows you begin the graph at a different point. The graph after that point will be expanded. Click on the desired point on the graph; a vertical line will display. Then select Move Time.

12. **Reset Time** resets the beginning of the graph to the original point.

*DSB Reported Effort and Averaging Results*

1. Reported data is what you choose to report as the final data on the patient report. The Reported column contains the effort(s) you choose using the Reported command from the Main menu. It is highlighted in blue or whatever color you chose in Configure. You may enter in a single effort or average more than one effort. In the actual effort columns, a value will have a blue box next to it if it is part of the Reported effort.

2. To enter efforts into the Reported column, conduct the steps below.

3. Click on the desired column to make it current.

4. Click on Reported, then on Add to Reported. The data entered into the Reported column will have a blue box next to it in the Current Column.

5. To make the Reported column the result of averaging, click on more efforts and then on Reported, and Add to Reported.

6. To take a set of data out of the Reported column, click on that column again and select Reported, then Remove from Reported.

7. Select Save from Main Menu in order to save an Average.

*Summary of Dsb Options*

1. The Main Dsb options are as described for the other test modules, except that the Reported option allows for averaging efforts.

*More Dsb Options*

2. Use the right-click menus for other options. Point to either of four areas: the DL graph (volume/time), the disability graph (which you can make appear in place of the DL graph), the washout graph (gas distribution), or the datasheet and right-click on the mouse. The following menus will display:

**Right-Click on the DL Graph**

**Copy DL Graph -** Copies the graph to the clipboard and enables you to paste it where you wish.
**Print DL Graph -** prints the graph
**View DL Graph -** Changes the view to the DL graph if the disability graph displays.
**View Disability Graph -** Changes the view to the Disability graph if the DL graph displays.
**Time Scale = *n* -** shows a time scale on graph of 0 to the number of minutes you select. This is the time allowed for the DSB test

**Right-Click on the Disability Graph**

**Copy Disability Graph -** Copies the graph to the clipboard and enables you to paste it where you wish.
**Print Disability Graph** - Prints the graph
View DL Graph - Changes the view to the DL graph if the disability graph displays.
**View Disability Graph** - Changes the view to the Disability graph if the DL graph displays.
**Graph All Disability Efforts -** All Disability Tracings will be overlaid on the graph.

**Right-Click on the Washout Graph**

The options Copy Washout Graph and Print Washout Graphs are the same as for all other right-click menus. The other options are described under *The Washout Graph*.

**Right-Click on Datasheet**

**Copy Datasheet and Print Datasheet -** Same as on all other right-click menus.
**Add to Reported -** Adds the selected effort to the Reported column as part of the Average.
**Remove from Reported -** Removes the selected effort from the Average in the Reported column
**Corrections -** Clicking on this option gives you a box with the opportunity to set the correction factors, which are as follows:

*Correction Factors for Effort #n*
**Hemoglobin (1-99): 14.60 -** The value displayed in the box is what you selected in the DSB Configuration program. You may enter in another value or simply press Enter to retain the current one.
**Carboxyhemoglobin -** The value displayed in the box is what you selected in the DSB Configuration program. You may enter in another value or simply press Enter to retain the current one.
**Altitude Correction -** If this box is not checked off and you want the Altitude Correction applied (for locations not at sea level), check it now. See DSB Configuration.
**Change all Efforts** - Check this box if you want the corrections to apply to all efforts.

Click on OK to keep these corrections or Cancel to exit without saving the changes made. You may add the corrections after as well as before the test to apply them. Data will be updated accordingly.

**NOTE:**
Many of these options are also available on the Main Program Edit menu.

**Exiting the Diffusion Program**

1. When ready to leave the Dsb program, be sure the desired Reported effort has been selected, as this is the one that will appear on the final Report.

2. Select Save to save the reported data.

3. Select the next desired Spirometry option.

**NOTE:**
Upon leaving the program, the screen will warn you if you have not saved data and give you an opportunity to do so.

## The $PI_{max}$-$PE_{max}$ Test

PImax/PEmax (MIPS MEPS) refers to Maximal Inspiratory and Maximal Expiratory Pressures respectively. The test measures these pressures by having the patient perform maximal inspiratory and expiratory efforts.

### Preparing the System for PImax-PEmax Testing

1. Take a clean MIP-MEP mouth assembly with attached tubing and connect the free end of the tubing to the Mouth port at the rear of the CPL.

2. Attach a large resizable mouthpiece, or an adapter and a pediatric mouthpiece, to the free end of the assembly. You may use a DC-2 filter if desired.

### PImax-PEmax Calibration

1. The PImax-PEmax module does not require daily calibration. However, the frequency of calibration is set by your system Administrator. Refer to *Section Four -- Calibration* for details.

2. If a valid calibration file for each of the devices involved in PImax-PEmax is not available, PImax-PEmax testing cannot be conducted. Perform and save a valid calibration file for any of the devices that require a valid calibration file:

   *Barometric Pressure/Temperature Probe*
   *Mouth Pressure*

### Conducting the PImax/PEmax Test

1. Before conducting the MIPS/MEPS test, make sure the desired patient and study are selected as described in Patient Testing. Click on the button to the right of the patient name to select Pre- or Post-drug testing. If performing Post-drug testing, refer to Conducting Post-Drug Testing.

2. In order for the software to recognize a maximal inspiratory or expiratory maneuver, certain plateau criteria must be met. Refer to PImax-PEmax Configuration to change this criteria if so desired. Other options, such as Reported Effort Selection Criteria and Graph scaling, may also be selected at test time by using the right-click menu items. Refer to PImax/PEmax Options.

3. To select the MIPS/MEPS test, click on Go To from the Main Menu, followed by PImax/PEmax. A screen with two panes will display the MIPS/MEPS graph, the data table and the following prompt line:

   *Start Test / Choose / Delete / Save / Reported / Undo*

4. The options that are grayed-out are for post-drug testing.

5. The test graph displays pressure in $cmH_2O$ versus time in seconds.

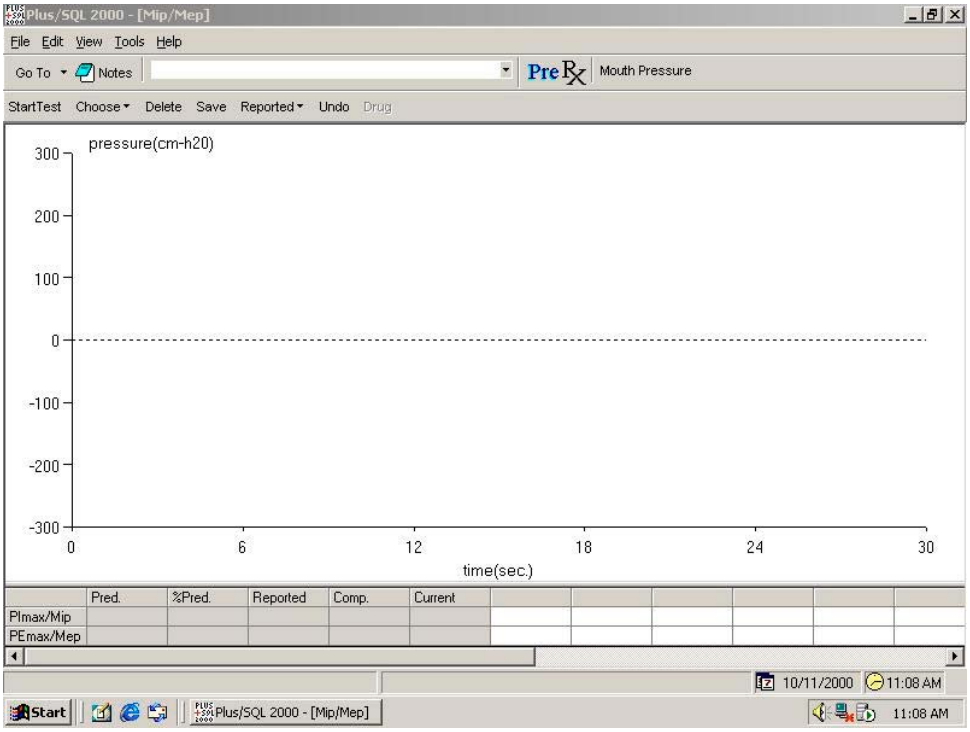



Figure 5-46. The Opening PImax/PEmax Screen

6. Place a noseclip on the patient and insert the MIP-MEP mouthpiece.

**NOTE:**
During the maneuvers, make sure that the calibrated aperture at the end of the mouthpiece is not blocked. It must remain open throughout the test to ensure correct results. This device corrects for pressure artifacts caused by use of facial structures.

7. First we will demonstrate the maneuver for measuring Maximal Expiratory Pressure.

8. In the following instructions, subsequent program messages will be written in italic.

9. Select Start Test.

10. The red zero pressure tracing will begin. Instruct the patient to inhale as deeply as possible, encouraging him to continue drawing in air until he has inhaled to maximum lung capacity.

11. Place your finger over the occlusion hole in the mouth assembly and instruct the patient to exhale as forcefully as possible. The tracing will rise as the pressure increases. Encourage the patient to continue forcing out his breath until he has pushed the tracing as high as possible.

    *Press spacebar to end Test, esc. to abort.*

12. When satisfied with results, press the spacebar to end the test. The program will draw a black horizontal line at the point on the tracing where the MEP was calculated and the MEP value in $cmH_2O$ will display on the datasheet.

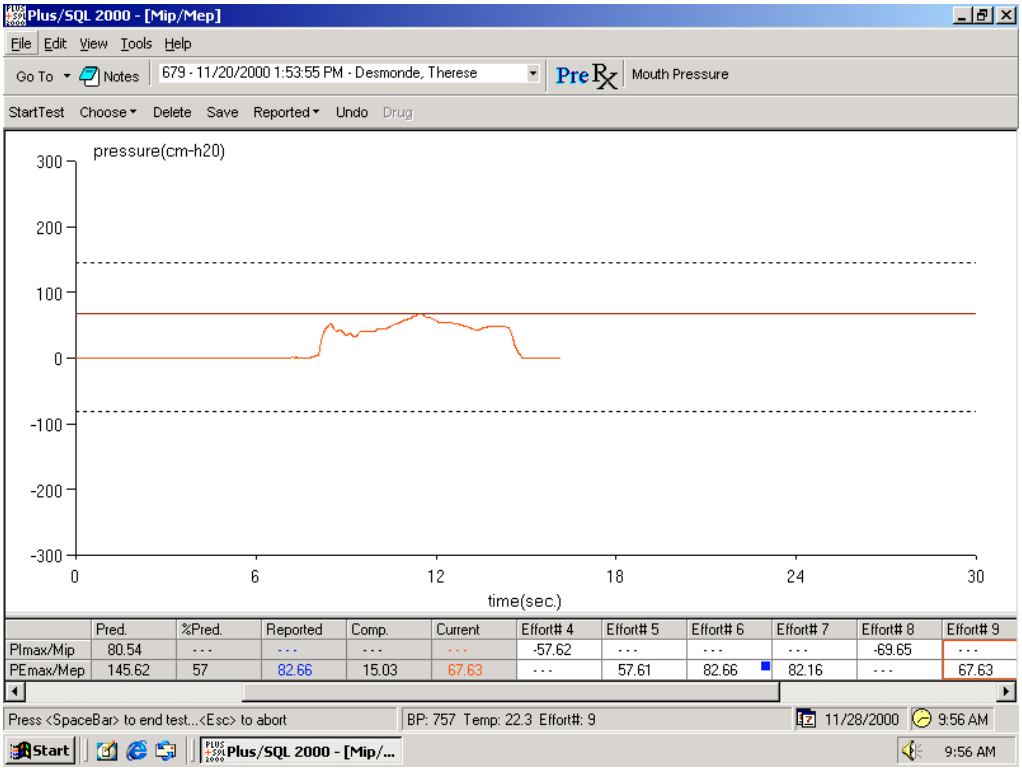



Figure 5-47. Sample Completed MEP Test

13. Now we will demonstrate the MIP maneuver. Select Start Test. When the red zero tracing begins, instruct the patient to exhale as deeply as possible, encouraging her to continue pushing out air until she has emptied her lungs.

14. Place your finger over the occlusion hole in the mouth assembly and instruct the patient to inhale as forcefully as possible. The tracing will increase in the negative direction as the pressure increases. Encourage the patient to continue inhaling as long and hard as possible.

15. When the patient can no longer inhale, press the spacebar to end the test. The datasheet with the MIP/MEP results will display below the graph.

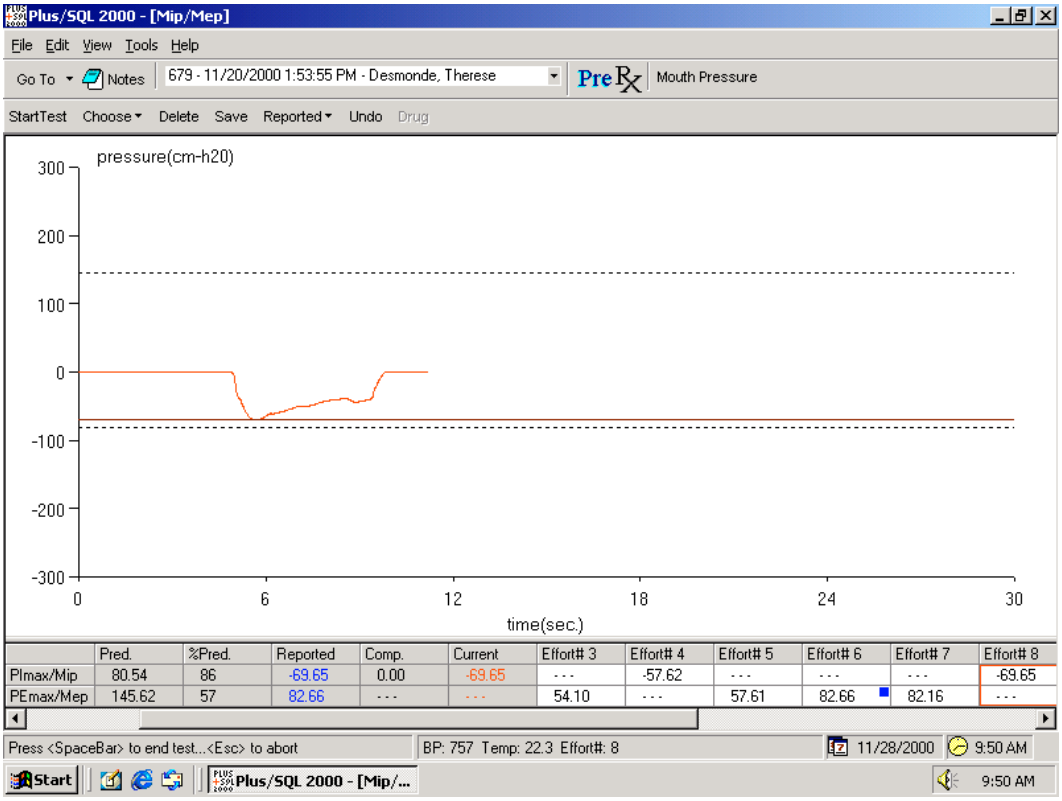



Figure 5-48. Sample Completed MIP Test

**NOTE:**

The MIP and MEP maneuvers may be combined in the same effort. Simply press the spacebar, inhale maximally, perform the MEP, then the MIP or vice versa, then press the spacebar to end the maneuver.

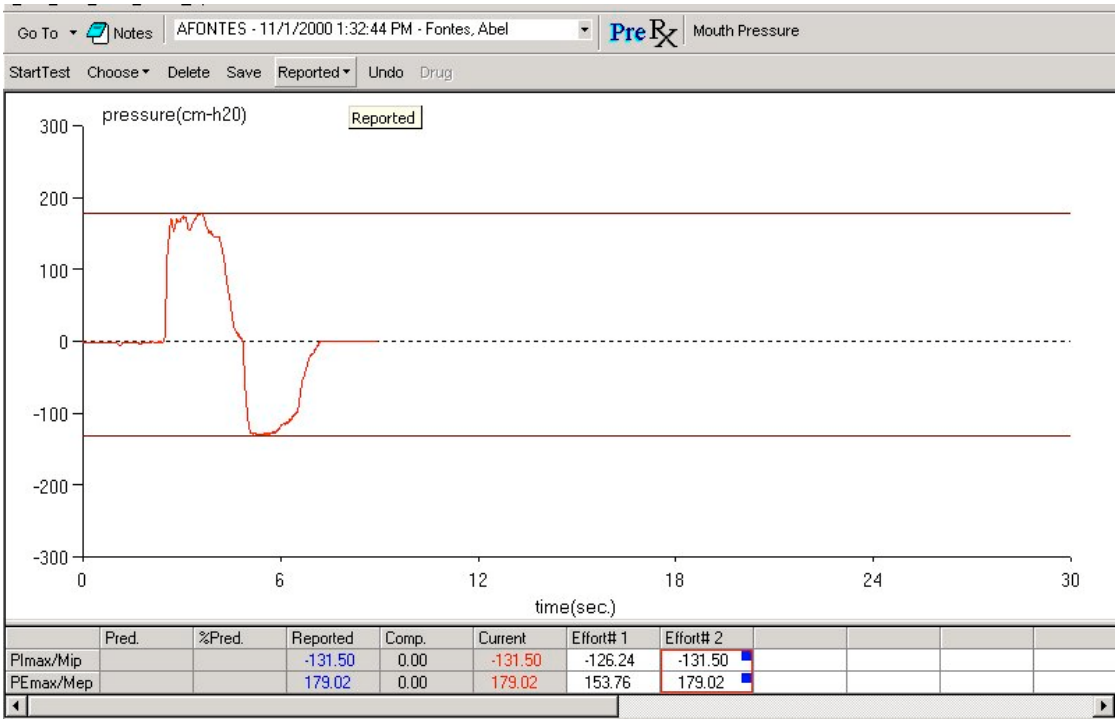



Figure 5-49. Sample Combined MIP/MEP Test

16. Refer to PImax/PEmax Review for an explanation of the resulting graph. Refer to PImax/PEmax Tabular Data for an explanation of the data.

17. You may accept 8 pre-drug MIPS/MEPS tests for one study. The data for the 8 most recently performed tests will display in the chart described above. When you have saved 9 tests, the program will prompt you to discard one effort in order to perform another.

18. You will be prompted to save the MIP/MEP data when you exit the test module. If you have not saved the data before exiting, do so by clicking on Save.

**PImax-PEmax Review**

1. At the completion of the test, the following can be observed:

   The real-time **PImax or PEmax** tracing will be recorded on the graph.
   The tabular data will display on the **datasheet**.

2. In order to delete an effort, click on it to make it current. Then select Delete from the prompt line. In order to undelete, select Undo from the prompt line.

3. Click on Reported in order to select the Best Effort criteria.

4. To save the data, click on Save from the Main MIPS/MEPS menu.

5. If you have more than one MIPS/MPES effort, to select an effort as the **Current** one, click on **Choose** or on the heading in the datasheet. The effort will be highlighted in red in the tabular column and the corresponding tracing will display on the graph.

*The PImax-PEmax (MIPS-MEPS) Datasheet*

1. The MIPS-MEPS datasheet is shown in the bottom pane of the 2-part MIPS-MEPS screen. You may scroll this screen from side to side to view more of it than fits in the window. The row headings are for the test parameters, which are PImax and PEmax. The column headings are identified by effort number and other categories described in the other test programs.

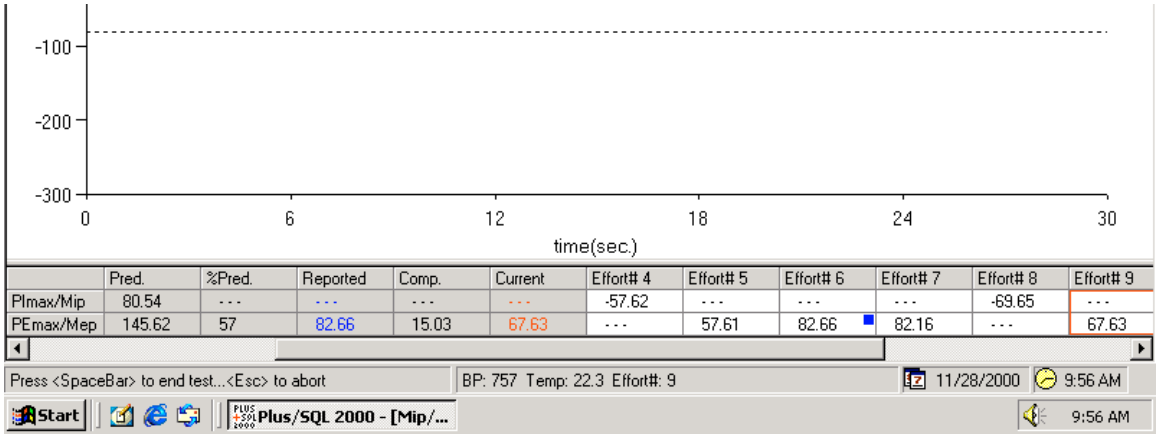



Figure 5-50. Sample MIP/MEP Datasheet

*PImax-PEmax (MIPS-MEPS) Reported Effort*

1. When reviewing MIPS/MEPS data, one of the columns in the datasheet will be highlighted in blue. This column, labeled Reported, contains the best effort according to whatever criteria you have selected in the Reported option or in the right-click options. This is the effort that will appear on the final report for that patient study.

2. Not all parameters in the Reported column will necessarily come from the same effort. In the actual effort columns, a value will have a blue dot next to it if it is part of the Reported effort.

3. To change the Reported selection criterion, position the mouse over the datasheet and right-click. In the bottom pane of the resulting menu are the following choices:

**AutoSelect:** Allows the program to select the best MIP and the best MEP, even if not from the same effort. These values will appear in blue in the Reported column. Also, in their respective effort columns, each of these values will have a blue dot next to it.
**MIP:** Click on an effort to make it current. Then select MIP from this menu. The MIP from the current effort will display in blue in the Best column and the MIP value will have a blue dot next to it in the Current (red) column.
**MEP:** Click on an effort to make it current. Then select MEP from this menu. The MEP from the selected effort will display in blue in the Best column and the MEP value will have a blue dot next to it in the Current (red) column.

*Summary of PImax-PEmax Options*

Most of the MIP-MEP options are the same as for the other test modules and are described in previous sections of this chapter. Here are a few more:

**Right-click on Graph:**

**Graph Autoscale** - volume scale based on size of graph produced. If no data produced yet, you will get a full-scale graph with this option.
**Time Autoscale -** Select the desired effort, then right-click and select Time Autoscale. Expands the area of the graph containing just the tracing, so that the tracing is on a larger scale. If no data produced yet, will get a full-scale time graph with this option.

**Exiting the PImax-PEmax Program**

1. When ready to leave the PImax-PEmax program, be sure the desired Reported effort has been selected, as this is the one that will appear on the final Report.

2. Select Save to save the reported data.

3. Select the next desired Spirometry option.

**NOTE:**
Upon leaving the program, the screen will warn you if you have not saved data and give you an opportunity to do so.

## FVC Challenge Testing

### About Challenge Testing

1. Challenge tests compare pre- and post-drug tests after a patient is given successively higher dosages of a drug that produces bronchial constriction.

2. The purpose of challenge testing is to measure a patient's respiratory response to increasing dosages of a provocative agent, such as cold air or a bronchoconstricting drug, in order to help diagnose certain airways diseases. This is typically done by first performing an FVC Forced Vital Capacity test with no challenge agent administered in order to establish a baseline for the desired measurements. The patient is then administered increasing dosages of the challenge agent, with an FVC test being performed immediately after each dosage until a particular percentage drop from the baseline value is observed. The dosage at which this drop occurs assists the clinician in evaluating the patient's condition.

3. As an example, a laboratory may wish to determine the dosage of a provocative agent required to drop a patient's $FEV_1$ the volume expired after 1 second of the FVC by 20%, as this would aid them in diagnosing certain airways diseases, such as asthma. The lab would first conduct a pre-drug study on the patient to see what his baseline $FEV_1$ was. They would then administer increasing dosages of a bronchoconstricting drug, such as methacholine or histamine. An FVC test would be repeated after administering each dosage. Testing would continue with the increasing dosages until the patient exhibited a positive response, which would be the 20% drop in $FEV_1$, or until personnel were satisfied that the response was negative.

4. The provocative dosage at which the positive response was observed would be noted and an evaluation would be made from this along with other pertinent medical information. In our example, the provocative dosage at which the drop occurs is referred to as the PD20, since we are looking for a 20% drop from the baseline. If we were looking for a 35% drop, the term would be PD35 (provocative dosage at which a 35% drop in a given parameter occurred).

**NOTE:**
A placebo (no provocative agent) is commonly administered for the first post-drug level and inhalation of the actual challenge agent not begun until the second level. In this case, the first post-drug level may be used as the control.

5. After a positive response has been observed, a bronchodilator is typically administered to the patient in order to reverse the effects of the challenge agent.

6. The challenge test must be monitored carefully, since it can potentially induce a harmful reaction in the patient. Therefore, challenge testing should be conducted only by highly trained personnel in a laboratory that is well equipped with resuscitation apparatus.

### Setting up the Dosimeter

1. The Dosimeter is used for automatic control of challenge testing. Set up the nebulizer and related equipment as described in the following steps.

2. Refer to the instructions accompanying the nebulizer for assistance. Assemble the nebulizer as instructed. Attach the mouthpiece to the appropriate port.

3. Attach the mouth pressure line to the fitting near the mouthpiece. The other end of the line is attached to the port labeled Mouth on the right rear panel of the CPL.

4. Attach the gas supply line to the port at the bottom of the nebulizer. The other end of the line is attached to the port labeled Dosimeter on the right rear panel of the CPL.

### Conducting Challenge Tests

1. If not already in the FVC program, access it as described in FVC Testing. Click on the PreRx button at the upper right corner of the opening window. The following menu will display:

*Pre-Drug*
*Post-Drug*
*Challenge*

2. Select Challenge. The opening FVC window will display. You will notice some menu items are available in the Challenge mode that were not available in pre-drug.

**NOTE:**
The program will inform you if you have not yet conducted any pre-drug FVC tests.

3. If you have not yet selected a challenge protocol, the program will direct you to choose one from the (FVC portion) of the Configuration Editor. A challenge protocol directs you on how to conduct the test for each level of challenge. When you have selected one, this will be the current protocol when you begin Challenge Testing.

**NOTE:**
A default Challenge protocol is provided for you if you have not configured any of your own, but it still must be selected. If you wish to configure a protocol, refer to Configuring FVC Challenge Protocols.

4. For post-drug FVC challenge tests, 20 levels (sets) may be conducted, with up to eight tests in each set. The effort numbers will be continuous throughout the levels of challenge. For example, if you have conducted 6 efforts in the pre-drug level, the first effort in the first challenge level will be number 7.

5. Click on Start Test. The program will display a window with the current challenge protocol.

6. To the right of the level information are the following option buttons:

**Start -** Begins dosimetry for the current challenge level.

**Nebulizer -** Allows continuous operation of the dosimeter, essentially making it a nebulizer. This button toggles the activation and deactivation of the nebulizer. No countdown is conducted prior to testing.

**Cancel -** Allows you to exit the protocol window without accepting a level.

**History -** You may turn the History chart at the bottom of the screen off and on by clicking this button. The chart gives a summary of what has happened so far in the Challenge test. It will be blank until you have completed a challenge level.

7. Select the first level by highlighting it and clicking on Accept. The program displays the Dosimeter Control window, with the breath recorded as zero.

8. Connect the patient to the dosimeter and instruct him/her to breathe normally. The system will automatically detect inspiration and trigger the dosimeter to deliver the drug at the appropriate time. The Dosimeter Control window displays the breath count each time the patient inspires.

9. The drug dosage (Concentration) will be administered during inspiration for the indicated time (Duration) for each breath specified (Number of Breaths).

10. When the last indicated breath has been taken, the program will begin a pre-set countdown. During this time the keyboard is locked and no action can be taken (except for (Esc) Abort). This quality control feature ensures waiting for the appropriate duration (Delay) so that the challenge agent can take effect.

11. When finished counting down, the system will automatically set up for an FVC test. At this point you may conduct the test as described for a pre-drug effort.

12. The number of breaths taken, the period of time the dosimeter is activated during each breath, and the delay in dosage after taking the breath is configured in FVC Challenge Configuration.

**NOTE:**

While in the protocol window of the test, you may make temporary changes to the protocol before conducting each level (such as in the number of breaths). However, when you return to the protocol for the next set, the original protocol data will be restored.

If, on the challenge protocol screen, the number of breaths ***and*** the duration are set to zero, when the Start button is clicked, the dialog for manual, external dosimeter usage is displayed. The drug is given and then the OK button is clicked to start the time delay countdown. When the countdown reaches zero, the bell is positioned for testing and everything proceeds as usual.

13. To override the dosimeter for a particular level, you may also click on Nebulizer and then on Accept. The dosimeter will deliver a continuous flow of the drug dosage for that level.

14. Eight efforts may be conducted for each set (level) of testing. Review the efforts in each level of testing as you would for the pre-drug level, selecting a Reported effort for each one. The drug dosage routine will be conducted only at the beginning of each set.

15. When finished with a set, save the data and click on Next Set in the Main Menu. The program will display:

    *Are you sure you want to start a new post-drug set? No efforts can be added to the current set once a new set is started.*

16. If not finished with the current set, click on NO. If you are finished and wish to proceed, click on Yes. The program will display the Protocol window again. Select the next level and click Accept. Then repeat the procedure as described above.

17. Repeat the above procedure for each level of the post-drug test until the desired results have been obtained.

18. To return to previous sets for review, click on SetNum from the Main Menu. and select the desired level number.

**NOTE:**

The percent change following bronchodilator administration is calculated as follows:

$$\% \text{ change} = \frac{\text{post-bronchodilator value - pre-bronchodilator value}}{\text{pre-bronchodilator value}} \times 100$$

Where *pre-bronchodilator values* and *post-bronchodilator values* are any Pulmonary Function variables (e.g., $FEV_1$).

## Manual Entry of Test Data

1. This section of the program allows you to add data to a study by typing it in. It is often used for adding blood gas data on a patient whom you've tested on the system.

2. Have the desired patient and study current (see Searching for a Patient). Click on the test phase button at the top right of the screen to select Pre or Post. From the Go To menu, select Manual Data Entry.

3. At the top of the resulting window will be the information for the selected patient. Below this is the data entry portion of the window.

4. From the option line, you may click on Search in order to select a different patient and/or study. When you have located the desired study, you may click on the study to get a list of the test categories conducted. You may then click on each test category to view the tabular results of each test conducted.

5. When the desired patient study displays, close the Search window.

6. Back at the Manual Entry window, click on the down arrow next to Test Type and the program will display the list of test types for which to enter information:

*Arterial Blood Gas*
*Diffusion Capacity*
*Functional Residual Capacity*
*Forced Vital Capacity*
*PImax/PEmax (MIP/MEP)*
*Maximum Voluntary Ventilation*
*Slow Vital Capacity*

7. Click on the desired test category. The program will display the columns:

   **Parameter -** Contains the list of parameters for this test category.
   **Predicted -** Contains a list of the patient's predicted values for each of the applicable parameters.

8. From the option line, click on Add effort. The first Effort # column will display. If this is a new study for the patient, it will be labeled Effort #1. If it's an existing study, the effort number will be resumed from the last effort accepted. For example, if you conducted 4 FVC tests, this Column will say Effort #5.

9. Enter in the data for each parameter in the first effort column. Use the arrows or the scroll bar to access more of the parameters than will fit in the window.

10. When finished, you may add another effort column by using Add Effort. A box in the upper right corner will list the number of efforts.

11. To delete a column entered, click on it and select Remove Effort.

12. When finished entering data for one test type, you may select another test type from the drop-down menu and proceed as described above.

13. To switch to another patient, click on Search.

14. Use the Save option at any time to save the data entered. Before exiting, click on Save.

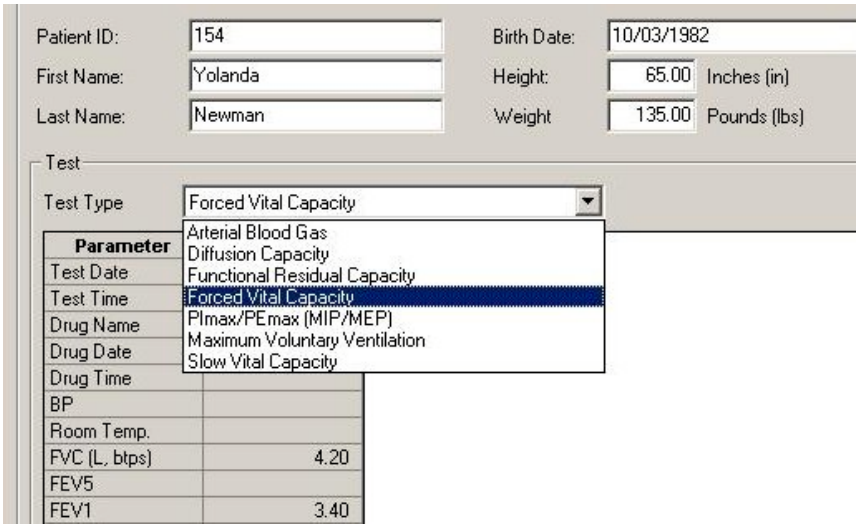



Figure 5-51. The Manual Entry Dialog

## BP$^{D}$ Calibration

If a valid calibration file for any one of the body box transducers is not available, BP testing cannot be conducted. Perform and save a valid calibration for all instruments involved in the BP testing, as described below.

### Calibrating the Barometric Pressure and Temperature Probe

1. Select *Calibration from* the Tools menu. The screen containing the Calibration Tree will display.

2. Double-click on *USB Box* to view the BP$^{D}$ transducers, along with symbols indicating the calibration status for each transducer. These symbols are defined in the Legend to the right. Refer to Section Four for more details on the Calibration Tree.

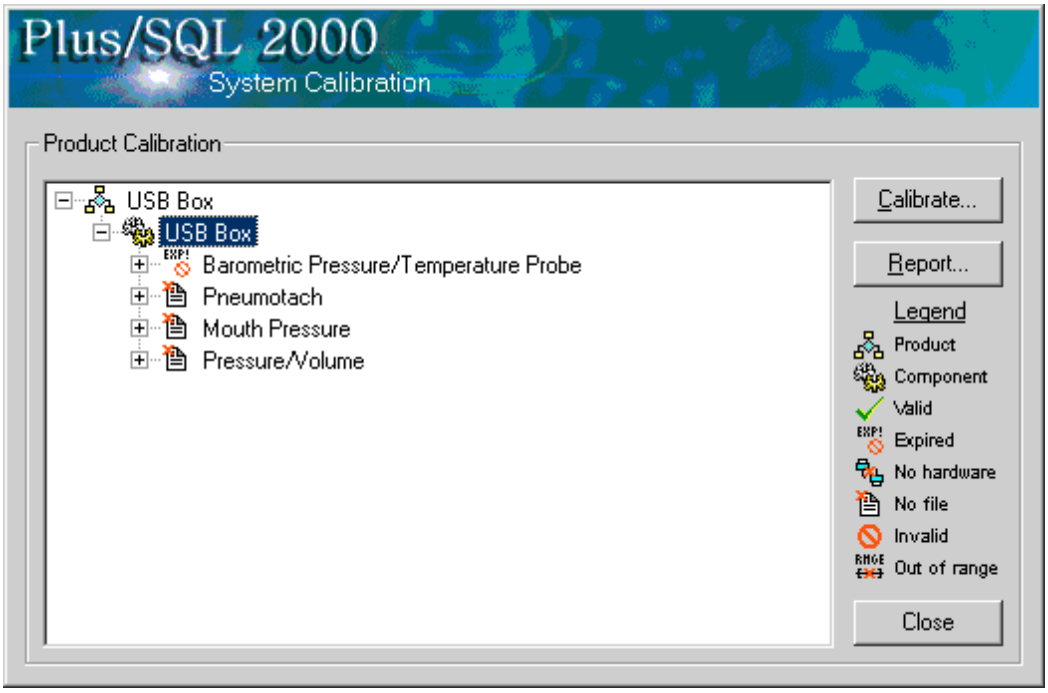



Figure 6-1. The Calibration Tree for the BP$^{D}$

3. Click on *Barometric Pressure/Temperature Probe* to highlight this option. Then click on the Calibrate button.

4. The program will display in succession the current box temperature and pressure recorded by the system. Press Enter to accept each one.

**NOTE:**
The temperature displayed here is the plethysmograph temperature, which may differ from ambient room temperature. The plethysmograph temperature is recorded automatically and is updated during testing.

5. If the procedure was successful, the program will display a message indicating such. Press the Spacebar to accept the new calibration values. Otherwise, press Esc to retain the old values. Then recalibrate.

6. Select *Verify* whenever you wish to verify the calibration.

**Calibrating the Pneumotach**

1. Have the pneumotach attached to the mouth shutter as described in the $BP^D$ hardware manual under *Preparing the System for Testing*.

2. On the Calibration Tree, highlight *Pneumotach* and click on the *Calibrate* button.

3. Pneumotach calibration is essentially the same as the procedure for calibrating the CPL Pneumotach in Section Four. Attach the breathing tube with the syringe all the way injected to the available (patient) side of the Pneumotach (the green connector should be closest to the syringe). Leave the plethysmograph door open during pneumotach calibration.

4. Follow the Recommended Verify procedure described in Section Four as well.

**Calibrating Mouth Pressure**

1. In order for mouth pressure calibration to be accurate, the top of the manometer gauge column must be set at zero to start with. Be sure to check the top of the column at eye level. If the column is not set at zero, loosen the thumbscrew at the side of the manometer and slide the ruler until the zero point lines up with the top of the gauge column. To assure accuracy when doing so, line up the meniscus in the gauge column with its mirror image in the ruler.

2. Connect the green tubing end of the manometer to the green pneumotach port on the $BP^D$ arm.

3. On the Calibration Tree, highlight *Mouth Pressure* and click on the *Calibrate* button.

4. The program will prompt you to make sure nothing is connected to the green port. This is a signal to remove the syringe from the manometer tubing. Then press the spacebar.

5. The program will direct you to inject 10 cm from the manometer. Completely withdraw the plastic syringe and reattach it to the manometer tubing

6. Push in on the syringe, injecting enough air to cause the gauge column to rise to the 10-cm mark. If you overshoot the 10 cm mark, simply withdraw the syringe to bring the column back down. When on the 10-cm mark, press the spacebar.

7. If the procedure was successful, the program will display a message indicating such. Press the Spacebar to accept the new calibration values. Otherwise, press *Esc* to retain the old values. Then recalibrate.

8. Select *Verify* whenever you wish to verify the calibration.

**Calibrating the Box Pressure-Volume Relation**

1. In this procedure, the pump will inject a known volume into the chamber. This volume will then be equated to the resulting box pressure response.

2. On the Calibration Tree, highlight *Pressure/Volume* and click on the *Calibrate* button. The program will prompt you to attach the pneumotach to the pump.

3. Remove the pneumotach from the mouth shutter. Insert it into the pump connector on the shaft just inside the $BP^D$ door, using the adapter provided. To do so, insert the non-patient end of the pneumotach into the threaded end of the adapter and slide the other end of the adapter into the pump connector. Have the green pneumotach connector facing away from the pump shaft.

4. Seal the box door, making sure you hear both electromagnets (at the top and bottom of the door) connect.

5. Press the spacebar. As the program waits for the box pressure to stabilize, a flat red line tracing will display. This is followed by the compensation tracing, which is a continuous loop.

6. The program directs you to adjust the box pressure compensation for loop closure using the Up and Down arrow keys. Using these keys, close the loop as much as possible.

7. When satisfied with the loop closure, press the spacebar to have the program calculate the Pressure-Volume reference. The program will display a tracing of the pump amplitude.

8. The pump amplitude tracing will end automatically, with dotted lines drawn at the endpoints and midpoints.

9. If the procedure was successful, the program will display a message indicating such. Press the Spacebar to accept the new calibration values. Otherwise, press Escape to retain the old values. Then recalibrate.

10. Select *Verify* whenever you wish to verify the calibration.

**NOTE:**
If you have problems with the loop not closing, make sure the $BP^D$ door is sealed (both electromagnets are engaged), then repeat the calibration procedure.

11. To print the calibration values, click on Report. Refer to *Section Four -- Calibration* for details.

## Plethysmography Testing

With the Collins Body Plethysmograph you can conduct plethysmography maneuvers, i.e., Lung Volumes (VTG) and Airways Resistance (Raw), as well as the Slow Vital Capacity (SVC) maneuver. The pneumotach in the $BP^D$ also allows you to conduct the spirometry maneuvers, FVC, MVV and PImax/PEmax. You would select the plethysmography options from the Plethysmography menu and the FVC, MVV and PImax/PEmax options from the Spirometry menu. When doing FVC, MVV and PImax/PEmax with the body box, be sure to select the Box as the device in the FVC, MVV and PImax/PEmax configuration options.

### Test Descriptions

*Lung Volumes (VTG)*

As explained in Appendix B under Theory, the test used to determine lung volumes in the body plethysmograph is commonly referred to as the VTG maneuver. VTG stands for Volume of Thoracic Gas, which in the Lung Volumes test is measured at Functional Residual Capacity (FRC). The actual VTG maneuver consists of light panting (60 breaths per minutes, i.e., 1 breath per second) against a shutter that is closed at end-expiration (FRC). Since a Slow Vital Capacity (SVC) maneuver follows the VTG maneuver, a complete set of lung volumes is obtained. In summary, the Lung Volumes sequence in the $BP^D$/PLUS program consists of tidal breathing, followed by the VTG maneuver, ending with an SVC maneuver.

*Airway Resistance (Raw)*

The actual Raw maneuver consists of light panting (180 breaths per minute, i.e., 3 breaths per second) through a pneumotach with the shutter open. It is necessary to know the lung volume at which the Raw maneuver was performed; therefore, Raw is preceded by a VTG maneuver, which consists of light panting against a closed shutter. The Raw maneuver is always conducted as part of the Combined maneuver.

*Slow Vital Capacity (SVC)*

A slow vital capacity maneuver is needed in order to obtain a complete set of Lung Volumes. The SVC may be conducted as a stand-alone test or as part of the Combined maneuver.

*Combined Tests*

The COMBINED option allows you to perform the Raw, VTG, and SVC maneuvers in a single test. The actual sequence consists of tidal breathing, followed by Raw, then VTG, and ending with SVC.

**Preliminary Tasks**

1. Before conducting tests with the Body Plethysmograph, have the system set up for testing as described in the Body Plethysmograph manual. If you wish, attach a DC-2 filter to the patient port of the pneumotach. The patient may breathe directly from the filter, or a clean, reusable, large rubber mouthpiece may be used.

> **NOTE:**
> The DC-2 is a disposable, low-resistance, barrier filter designed for use in preventing patient droplet contamination of pulmonary equipment, thereby preventing patient cross-contamination. Refer to the *Supplies Listing* in your Body Plethysmograph manual for ordering information
>
> The default value for filter deadspace in $BP^D$ Configuration is 0.089. This value assumes the use of the DC-2 filter without the rubber mouthpiece. If using the rubber mouthpiece, enter 0.093 for this value in $BP^D$ Configuration (refer to Body Box Configuration in Section Three). If using a filter other than the Collins DC-2 filter, it will be necessary to enter in another value.

2. If you wish to configure the Plethysmography option, refer to Body Box Configuration in Section Three. Otherwise the system defaults will remain in effect.

3. The $BP^D$ system must be calibrated as described above. If a valid calibration file for each of the $BP^D$ transducers is not available, testing cannot be performed.

4. Before you start testing, you must first create a patient study for the desired patient in the Patient Information option or select an appropriate existing study from the PLUS database. (See Section Two on Creating Patient Studies and working with the patient cache.)

**Conducting Tests**

1. PLUS software has been designed to allow pre- and post-drug testing for each test type. When a test type is selected, the system defaults to PRE. In order to select Post-drug testing, click on the Pre button at the top right corner of the screen and select Post-drug from the menu.

2. For each test type, 8 efforts can be saved for each pre- and post-drug level. If you wish to conduct more than 8 efforts, you must discard one in order to do another. For FVC challenge tests, 20 levels (sets) may be conducted, with up to eight tests in each set.

3. To select Body Box testing, click on the GO TO button, then Patient Tests, and then Plethysmography. The PLETHYSMOGRAPHY screen will display the following options:

*Start Test / Choose / Delete / Save / Reported / Undo /Drug / RawBTPS (+) RawBTPS (-)*

The options that are not currently active (such as those for Review) are grayed-out for now.

4. Click on Start Test. The following options will display:

*Combined*
*Lung Volumes*
*SVC*

The Combined option consists of the Raw, VTG, and SVC maneuvers.
The Lung Volumes option consists of the VTG and SVC maneuvers.
The SVC option consists of the SVC maneuver alone.

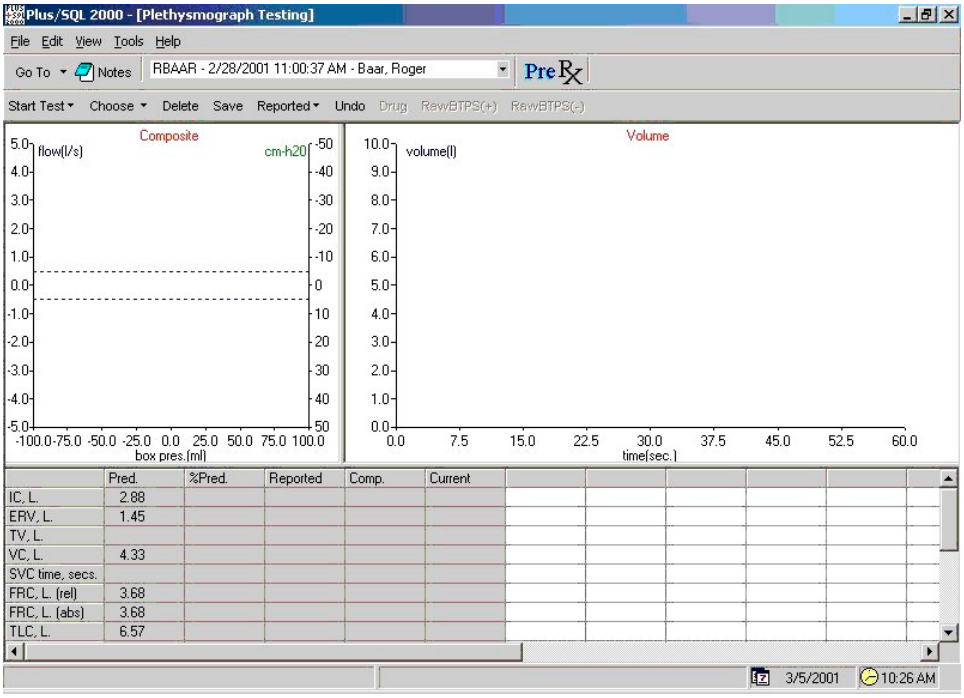



Figure 6-2. The Plethysmography Opening Screen

5. Here we will describe the Combined option, since this includes all the available plethysmography maneuvers. The Combined mode automatically takes you through a complete test sequence. Press the spacebar wherever directed to by the program.

*The Combined Maneuver*

6. Click on *Combined*.

**NOTE:**

Pressing the Ctrl and T keys simultaneously when at the opening Plethysmography screen will automatically take you into the Combined test without having to select it from the drop-down menu.

7. The screen will display the graphs for three maneuvers. Counterclockwise from the bottom, they are for tidal breathing and SVC, Raw and VTG. The sequence for the Combined maneuver is written at the bottom of the screen for you to refer to.

8. Once you have selected Combined, the door electromagnets are energized, the microphone is activated and the program prompts you to close the chamber door.

9. Close the $BP^D$ door, making sure it is sealed (both electromagnets, top and bottom, are engaged, i.e., they "grab").

10. As directed, insure that there is no flow through the pneumotach as the zero-offset for the pneumotach is updated. This is an automatic process that takes only a few seconds. During this period no flow or other disturbance should be introduced in the area of the plethysmograph.

11. Have the patient sit inside the chamber. Inform the patient that if he needs to speak to you while in the chamber, to simply do so; the microphone will simply transmit the sound to you. Make the patient aware of the red door-release button on the inside, as this will help reduce anxiety for patients who fear closed-in spaces.

12. Instruct the patient on the proper test procedure. Tell the patient that you will notify him just before the shutter closes for the VTG maneuver. Also, coach the patient through the intercom during the maneuver to insure that the test is performed correctly.
13. Attach a fresh DC-2 filter to the patient side of the pneumotach. If using a mouthpiece, attach a fresh reusable one to the DC-2 filter or the pneumotach (refer to the NOTE under *Preliminary Tasks* for information about correcting for filter and

mouthpiece deadspace). Attach a noseclip to the patient and connect him/her to the mouthpiece or directly to the DC-2 filter. Gently close and seal the $BP^D$ door by making sure both electromagnets are engaged.

**NOTE:**

Due to thermal drift, body plethysmographs traditionally require a warm-up period after the patient enters the chamber. However, the Collins plethysmograph has been designed to compensate for thermal drift, allowing the patient to perform the maneuver right after entering the chamber.

14. In the following steps, pressing the spacebar at the appropriate moments will advance the program through the automatic test sequence.

15. Have the patient breathe normally at the mouthpiece for a few moments. When he is comfortable at the mouthpiece, press the spacebar to begin recording tidal breathing. The tracing will appear on the volume history graph at the bottom half of the screen.

16. The Volume History tracing is conducted to establish the patient's end-tidal level, or FRC. This data will be used to determine the relationship between VTG and FRC during the subsequent maneuvers. If an even baseline has not been established by the time the tracing reaches the end of the screen, press E for Erase and start recording a fresh tracing.

17. A vertical line will be laid on the Volume History graph at the point where the end-tidal level has been established. When this occurs, press the spacebar to progress to VTG measurement. Immediately prior to pressing the spacebar for VTG, inform the patient that the shutter will be closing and that he should start panting when it does.

**NOTE:**

It is not necessary for the operator to control exactly where the shutter is closed for VTG. No matter at what volume it is closed, the program will correct the measured VTG to get back to the FRC established during the initial tidal breathing.

18. The program advances to the VTG graph and the mouth shutter closes for the VTG maneuver. Have the patient attempt to pant easily against the closed shutter for the number of breaths specified in Plethysmography Configuration (the default is 5 breaths), keeping his glottis open and his cheeks as rigid as possible. He may keep his cheeks rigid by pressing his palms against them. Breathing for the VTG maneuver should be at the rate of 60 breaths per minute (1 breath per second).

19. If the VTG data becomes untidy, all Vtg data can be cleared from the pane by pressing the Vtg (V) key. Upon clearing the Vtg pane, the Vtg breath counts will restart at one (1).

**CAUTION:**

If the Erase (E) key, which clears ALL graphical data panes, is used to clear the Vtg pane, you will loose ALL graphical data, including the volume history. Be sure to use the V key to clear the Vtg pane.

20. At the conclusion of the Vtg maneuver, the graphical data plot will return to the volume history pane. At this point, prompt the patient to begin panting lightly at a rate of 180 breaths per minute (3 breaths per second), keeping his glottis open and his cheeks as rigid as possible. He may keep his cheeks rigid by pressing his palms against them, as in the Vtg maneuver.

21. When the patient has attained a smooth pant, press the spacebar to advance to the Raw pane. The patient will continue panting, this time with the shutter open. Overlapping Raw breath data will be displayed until the patient has reached the number of breaths specified in Plethysmography Configuration (the default is 7 breaths). Dotted lines on the graph represent zero and plus and minus .5 L/sec. (this default may be changed in Plethysmography Configuration). Refer to the discussion under “Acceptable Tracings” for an explanation of these lines.

22. If the Raw data becomes untidy, all Raw data can be cleared from the pane by pressing the Raw (R) key. Upon clearing the Raw pane, the Raw breath counts will restart at one (1).

**CAUTION:**

If the Erase (E) key, which clears ALL graphical data panes, is used to clear the Raw pane, you will loose ALL graphical data, including the volume history. Be sure to use the R key to clear the Raw pane.

23. Once an acceptable Raw tracing has been obtained, prompt the patient to return to normal breathing. The tracing will revert to the Volume History pane once again.

24. When three stable breaths have been recorded, have the patient perform the SVC maneuver. That is, have him expire maximally until he reaches residual volume (RV), then inspire maximally to total lung capacity (TLC) without attention to speed. Tell the patient to return to normal breathing and press the spacebar to end the test.

**NOTE:**

The order of the expiratory and inspiratory maneuvers in the SVC is immaterial and can be done as expiration to residual volume first, followed by maximal inspiration to total lung capacity, or visa-versa. The software determines the maximum point of inspiration and maximum point of expiration, following the point on the volume curve at which the end-tidal level was determined.

25. When the test is completed, click on Save to save it.

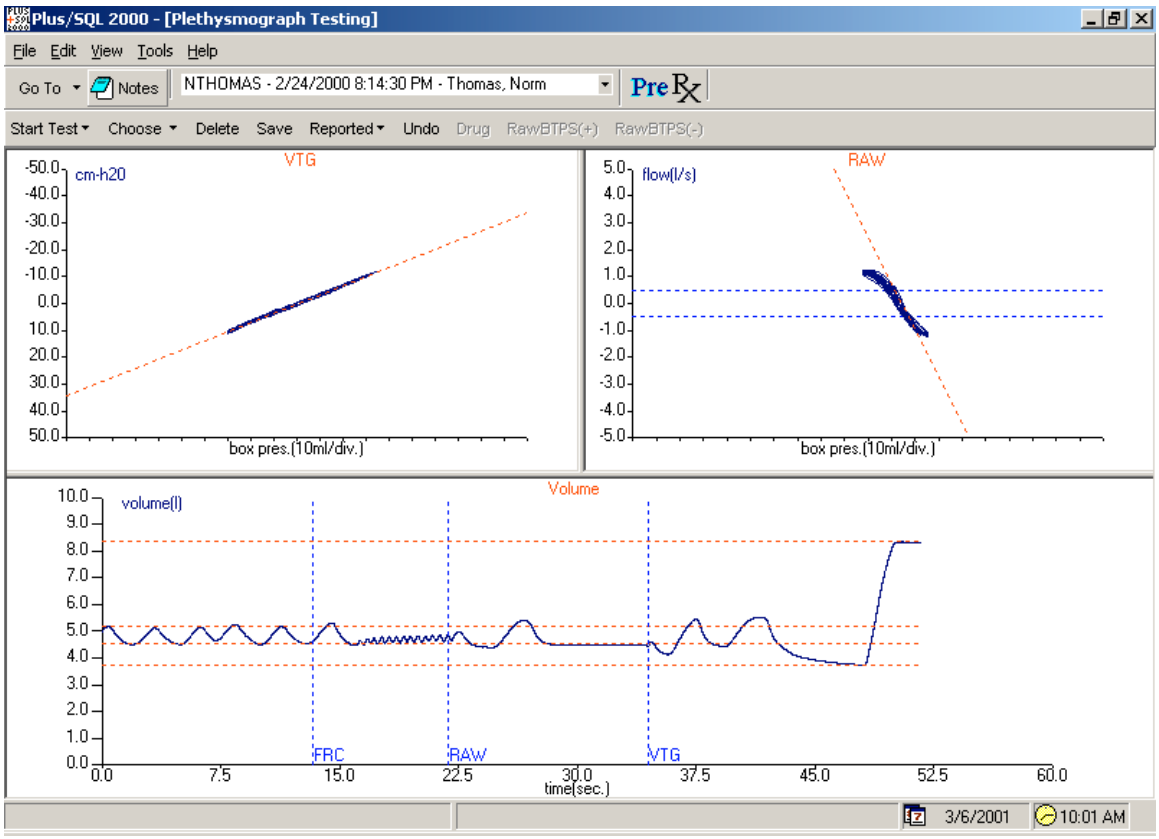



Figure 6-3. A Completed Combined Test Screen

*Notes on the Combined Maneuver*

Breaking out of the Combined Maneuver to Conduct Manual Tests

If at any time during the combined maneuver you wish to break out of the preprogrammed sequence and perform ad-lib Vtg or Raw maneuvers, press the <V> key to advance directly to the Vtg mode or the <R> key to advance directly to the Raw

mode, rather than pressing the spacebar. Pressing either of these keys breaks the combined sequence and places the program in the manual mode. As described above, to clear the data in the Vtg or Raw pane, without losing the volume history data, press the <V> or <R> key respectively, rather than the Erase (E) key. Once the Vtg or Raw modes have been manually triggered, data collection in the selected test mode will continue until the configured number of breaths for that test type have been reached, at which point graphical data plotting will revert to the volume history pane. Pressing the spacebar when program focus is in the volume history pane will terminate the test.

Acceptable Tracings

The main criteria for an acceptable Raw tracing is that it be consistent. This is usually indicated by an overlap in the multiple tracings obtained. If the tracing tends to move across the screen instead of overlapping, this may be an indication that the patient is not panting at a consistent volume.

The dotted lines on the Raw graph represent plus and minus .5 liters per second (this default may be changed in PLETHYSMOGRAPHY Configuration), plus being expiration and minus being inspiration. Based on the data, the program automatically establishes the Raw angle between plus and minus .5 liters per second, as is the standard. Therefore, during the Raw maneuver, the patient should breathe deeply enough so that the tracing includes these two points. However, if the patient is breathing too deeply, the tracing will flatten out at either end and form serif-like lines. Breathing at a rate of about three breaths per second should avoid such a tracing. Refer to Figure 6-3 for an acceptable Raw tracing.

The program uses the middle third of the VTG tracing in order to determine the angle; therefore, if the tracing flattens out on the end, this portion will not figure into the calculations. However, the VTG maneuver should form a clear and consistent angle. Breathing should be at the rate of about one breath per second. Refer to Figure 6-3 for an acceptable VTG tracing.

Conducting Stand-alone Lung Volumes and SVC Tests

1. To perform individual tests, click on the Start Test button and select the desired test from the drop-down menu. The options are as follows:

   *Combined*
   *Lung Volumes*
   *SVC*

   *Lung Volumes* consists of the VTG and SVC maneuvers.
   *SVC* allows you to conduct an SVC alone.
   The *Raw* test requires the VTG test, so is always conducted as part of the *Combined* test.

2. When you select each of these options, the test sequence is written at the bottom of the screen for you to refer to.

3. For the Lung Volumes option, follow the same test startup sequence as described for the Combined mode, above. Volume data will be collected and displayed until the end-tidal level is determined. When the vertical line is displayed on the volume tracing, indicating that the end-tidal level has been established, press the spacebar to perform a Vtg maneuver. When the configured number of pants are completed for Vtg, the program will return to the volume-history pane, where you should then conduct the SVC maneuver as described under Combined.

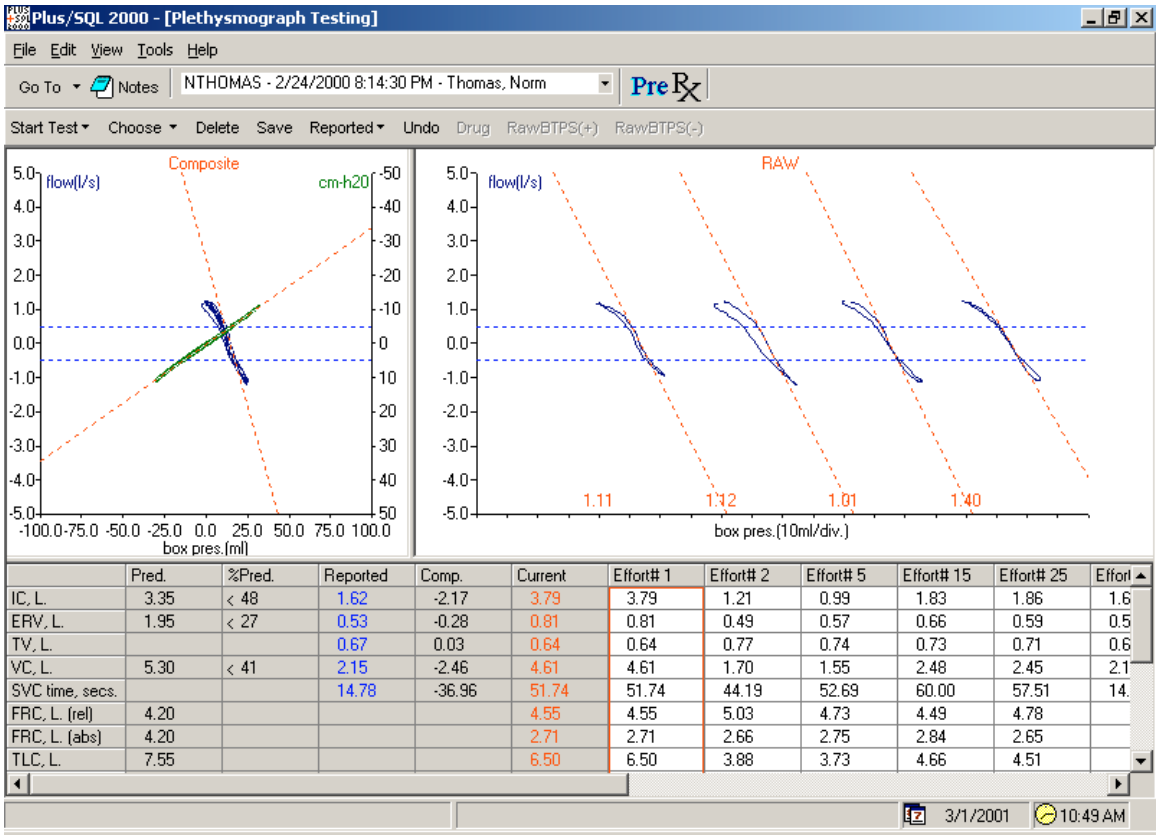
4. If you select SVC, instruct the patient to breathe quietly until the vertical line is displayed, indicating that the end-tidal level has been established. Then have him blow all the way out to Residual Volume (RV) followed by a maximum inspiration to Total Lung Capacity (TLC) and then return to normal breathing. Press the <spacebar> to end the test.

## Plethysmography Review and Editing Options

### Graph Review

*Windows® View Menu Option*

The Windows® View menu option allows the operator to select either the Real-time test screen, as seen in Figure 6-3, or the Standard Plus/2000 Review screen, as seen in Figure 6-4. This menu also allows you to select the Lung Volumes, Vtg or Raw tracings to review.




| | Pred. | %Pred. | Reported | Comp. | Current | Effort# 1 | Effort# 2 | Effort# 5 | Effort# 15 | Effort# 25 | Effort |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IC, L. | 3.35 | < 48 | 1.62 | -2.17 | 3.79 | 3.79 | 1.21 | 0.99 | 1.83 | 1.86 | 1.6 |
| ERV, L. | 1.95 | < 27 | 0.53 | -0.28 | 0.81 | 0.81 | 0.49 | 0.57 | 0.66 | 0.59 | 0.5 |
| TV, L. | | | 0.67 | 0.03 | 0.64 | 0.64 | 0.77 | 0.74 | 0.73 | 0.71 | 0.6 |
| VC, L. | 5.30 | < 41 | 2.15 | -2.46 | 4.61 | 4.61 | 1.70 | 1.55 | 2.48 | 2.45 | 2.1 |
| SVC time, secs. | | | 14.78 | -36.96 | 51.74 | 51.74 | 44.19 | 52.69 | 60.00 | 57.51 | 14. |
| FRC, L. (rel) | 4.20 | | | | 4.55 | 4.55 | 5.03 | 4.73 | 4.49 | 4.78 | |
| FRC, L. (abs) | 4.20 | | | | 2.71 | 2.71 | 2.66 | 2.75 | 2.84 | 2.65 | |
| TLC, L. | 7.55 | | | | 6.50 | 6.50 | 3.88 | 3.73 | 4.66 | 4.51 | |

Figure 6-4. A Standard PLUS/2000 Review Screen for Plethysmography

*Magnification*

A magnification feature is available for use when viewing all graphical panes. Place the tip of the mouse pointer at a point above and to the side of the area you wish to enlarge. While holding the left mouse button down, drag the mouse across and down the region you wish to enlarge. A box will be displayed. When the left mouse button is released, the region enclosed by the box will be enlarged to fill the entire graphic pane and the scales will be adjusted as appropriate. Left-clicking the mouse with the pointer on the enlarged area will return the graph pane to its original scale. Dragging the box outside the pane will have the effect of reducing the size of the area selected.

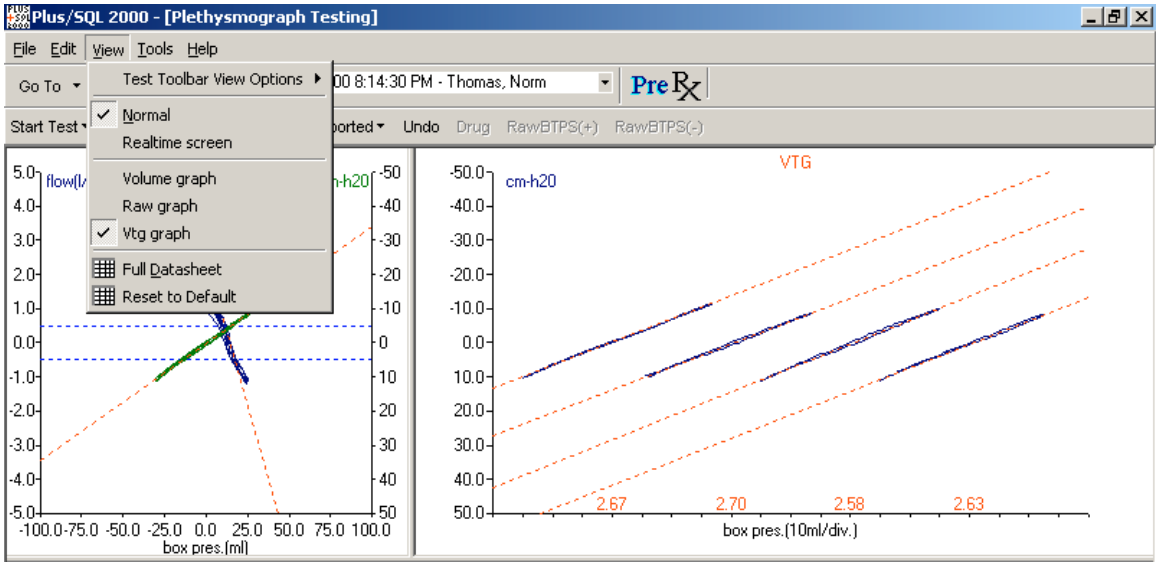



Figure 6-5. A Normal Size VTG Screen

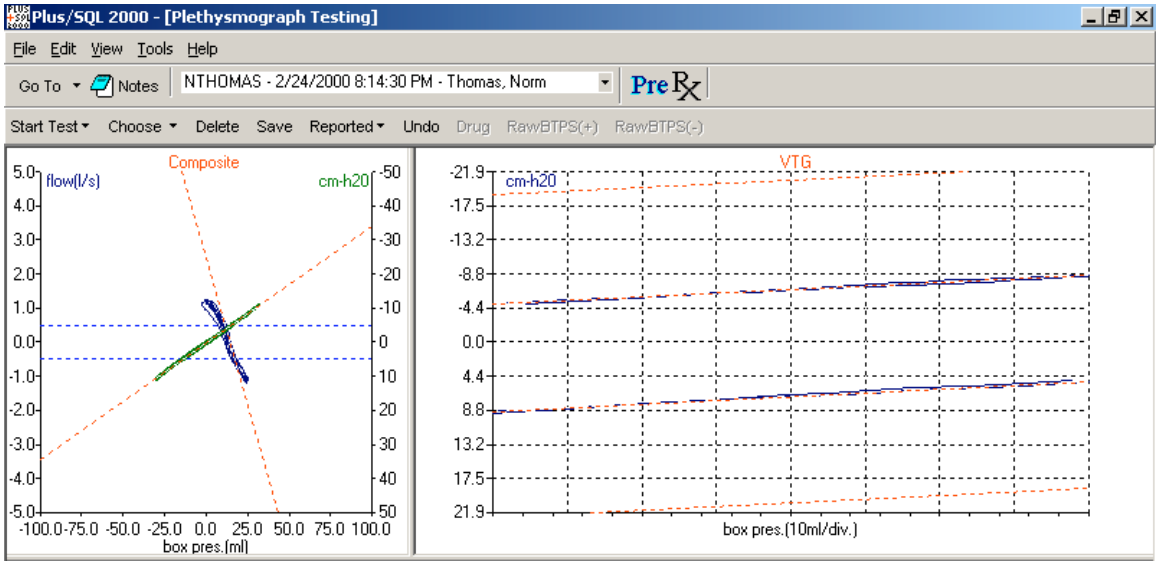



Figure 6-6. A VTG Screen Magnified

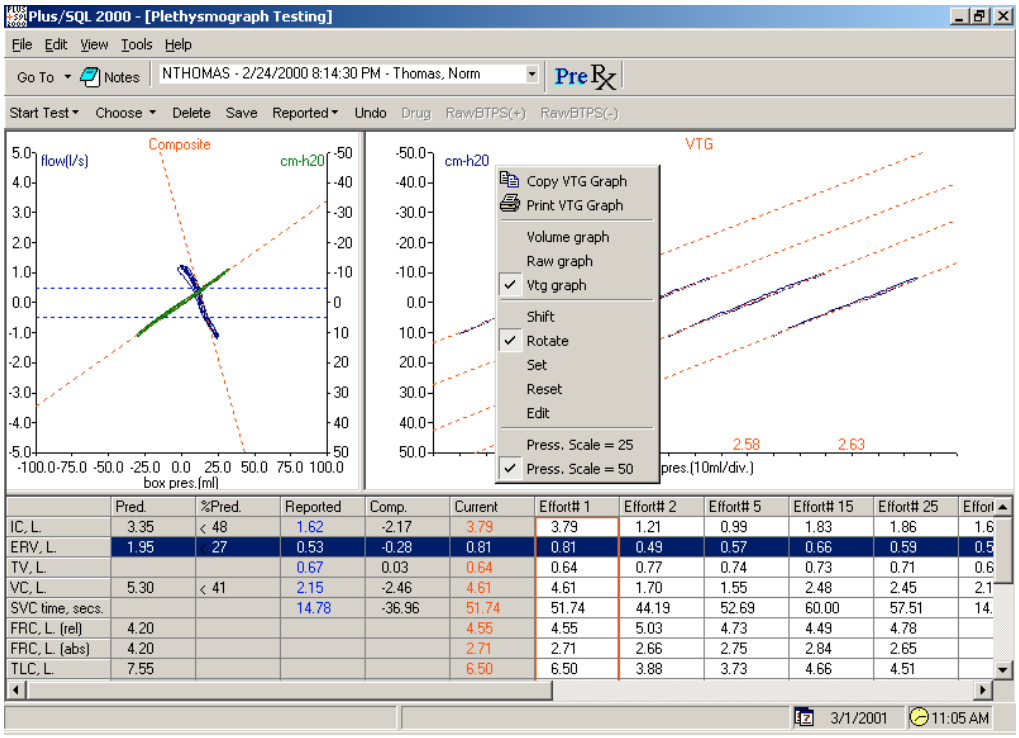
*Adjusting Best-Fit Lines for Vtg and Raw Calculations*

1. The individual breaths recorded for a Vtg or Raw maneuver can be displayed to allow the user to override the computer-generated best-fit lines with lines positioned according to the operator's own personal criteria.

2. To review and manipulate the data for a specific effort, set the desired effort in the tabular data pane as the Current effort by placing the mouse pointer on the effort number cell and left-clicking. The effort clicked becomes the Current effort and a red border is drawn around that column of data. This data is displayed in the Currently Selected Effort column and the graphical data for this effort is displayed in the graph panes above.

3. Place the mouse pointer in the upper right graph pane and right-click. A context menu will be displayed. Left-click on the test type you wish to examine, Lung Volumes, Vtg or Raw. For Vtg or Raw, the individual breaths contained in that data will be separated out and displayed separately in the right graphical pane.

4. Placing the mouse pointer and right-clicking will pop-up a context menu offering several editing options. These options allow the user to rotate lines, shift lines without changing the angle, accept the changes by clicking Set, or Reset lines that have been manually repositioned to the original computer positioning.




| | Pred. | %Pred. | Reported | Comp. | Current | Effort# 1 | Effort# 2 | Effort# 5 | Effort# 15 | Effort# 25 | Effort |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IC, L. | 3.35 | < 48 | 1.62 | -2.17 | 3.79 | 3.79 | 1.21 | 0.99 | 1.83 | 1.86 | 1.6 |
| ERV, L. | 1.95 | < 27 | 0.53 | -0.28 | 0.81 | 0.81 | 0.49 | 0.57 | 0.66 | 0.59 | 0.5 |
| TV, L. | | | 0.67 | 0.03 | 0.64 | 0.64 | 0.77 | 0.74 | 0.73 | 0.71 | 0.6 |
| VC, L. | 5.30 | < 41 | 2.15 | -2.46 | 4.61 | 4.61 | 1.70 | 1.55 | 2.48 | 2.45 | 2.1 |
| SVC time, secs. | | | 14.78 | -36.96 | 51.74 | 51.74 | 44.19 | 52.69 | 60.00 | 57.51 | 14. |
| FRC, L. (rel) | 4.20 | | | | 4.55 | 4.55 | 5.03 | 4.73 | 4.49 | 4.78 | |
| FRC, L. (abs) | 4.20 | | | | 2.71 | 2.71 | 2.66 | 2.75 | 2.84 | 2.65 | |
| TLC, L. | 7.55 | | | | 6.50 | 6.50 | 3.88 | 3.73 | 4.66 | 4.51 | |

Figure 6-7. Sample Context Menu

5. To rotate a line, click on Rotate and Edit from the Context menu to activate these functions. Left-click on the desired line in the graph and drag the line to the desired position. You will notice the corresponding numeric value on the graph change. To return the line to its original position, select Reset from the Context menu. To save it in the new position, select Set.

6. Do the same as in the preceding step to shift a line.

7. If you wish to fine-tune your moves during Rotate or Shift, position the cursor farther out from the tracing while moving the line (you may position the cursor to the far corner of the screen even). Position the cursor closer in to the tracing to coarse-tune your moves, that is, to move the line in larger increments.

8. To delete a breath, select Edit from the Context menu. Click on the line to delete. Then click on Delete from the Context menu. The line will be grayed-out.

9. Note that Delete acts a toggle. Therefore, to restore a deleted line, select Edit, click on the grayed-out line, and select Delete again.

**NOTE:**

The right-click context menu available during the Raw test review contains the option Edit Raw BTPS. This option will active the BTPS(+) and BTPS(-) buttons on the plethysmography tool. This function is conducted only under special circumstances and not done in routine plethysmography.

*Positioning Tidal Breath Lines*

On the Lung Volume Review screen, the upper right graphic pane will display the Volume History tracing with dashed horizontal lines. These lines delineate tidal breath by indicating the end-expiratory level and the end-inspiratory level, the top

of the residual volume level, and the total lung capacity. The Edit command on the right-click context menu allows the user to override the computer positioning of these lines. Again, click Set on the context menu to accept the changes, or click Reset to return the lines to the original computer positioning.

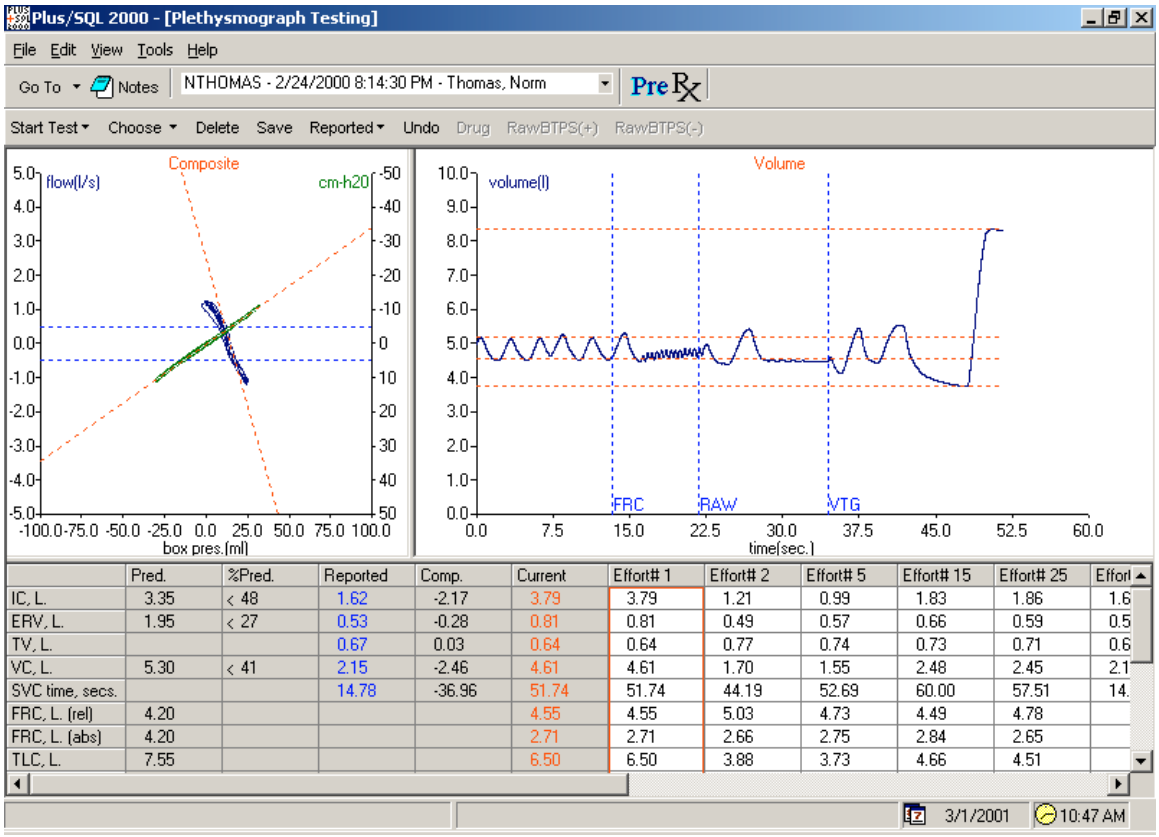

Plus/SQL 2000 - [Plethysmograph Testing]
File Edit View Tools Help
Go To Notes
NTHOMAS - 2/24/2000 8:14:30 PM - Thomas, Norm
Pre Rx
Start Test Choose Delete Save Reported Undo Drug RawBTPS(+) RawBTPS(-)
Composite
flow(l/s)
cm-h2O
box pres.(ml)
Volume
volume(l)
FRC
RAW
VTG
time(sec.)
Pred. %Pred. Reported Comp. Current Effort# 1 Effort# 2 Effort# 5 Effort# 15 Effort# 25
IC, L. 3.35 < 48 1.62 -2.17 3.79 3.79 1.21 0.99 1.83 1.86
ERV, L. 1.95 < 27 0.53 -0.28 0.81 0.81 0.49 0.57 0.66 0.59
TV, L. 0.67 0.03 0.64 0.64 0.77 0.74 0.73 0.71
VC, L. 5.30 < 41 2.15 -2.46 4.61 4.61 1.70 1.55 2.48 2.45
SVC time, secs. 14.78 -36.96 51.74 51.74 44.19 52.69 60.00 57.51
FRC, L. (rel) 4.20 4.55 4.55 5.03 4.73 4.49 4.78
FRC, L. (abs) 4.20 2.71 2.71 2.66 2.75 2.84 2.65
TLC, L. 7.55 6.50 6.50 3.88 3.73 4.66 4.51
3/1/2001
10:47 AM

Figure 6-8. The Lung Volumes Review Screen

*Copying or Printing of Graphical Data*

The right-click context menu contains options that allow the data displayed in the graphical panes to be copied to the Windows® clipboard and then pasted in other applications. There is also a Print Graphical Data option that sends the data in the graphical data pane to the selected system printer.

*Graph Scaling*

The right-click context menu for each graphical pane allows the operator to select from a variety of scale factors appropriate for the graphical data being displayed.

**Tabular Data Review Functions**

1. As in graphical review modes, placing the mouse pointer anywhere in the tabular data pane and right-clicking will pop-up a context menu offering a variety of tabular data review options. Context menu selections to Copy Tabular Data to the Windows® clipboard, or to Print Tabular Data to the currently selected Windows® printer are available.

2. The *Report All, Report SVC, Report LV*, and *Report Raw* selections allow the operator to average any combination of available tabular data into the Reported column. The data in the Reported column is what will appear in the final patient Report.

For example, select effort #2 as the Current effort. If you then select *Report All*, all of the data for effort #2 will go into the Reported column. The test parameters in the effort #2 column will each be marked with a blue box to indicate that this data has been incorporated into the Reported column.

Select # 3 as the Current effort. If you then select *Report All*, all of the data for effort #3 will be averaged with all of the data for effort #2 in the Reported column.

Instead of reporting all data for each effort, you may take just portions of each effort to average into the Reported column by selecting one of the other options besides *Report All*. The selected data for the test-type clicked will be copied from the currently selected effort. Also, the test parameters for the selected test type in the currently selected effort column will be marked with a blue box to indicate that this data has been incorporated into the Reported column.

The *Report All, Report SVC, Report LV*, and *Report Raw* options act as toggles. For example, if, after having entered all data for one effort into the reported column, you select the same effort again and select Report All, the data will be removed from the Reported column.

*Tabular Data Pane Control Functions*

1. The right-click context menu for the tabular pane has an option for Full Datasheet, which expands the datasheet (and shrinks the graph panes as necessary) so that all tabular parameters can be viewed without the need to scroll.

2. The Reset Datasheet option resets the datasheet to its original size and restores the graphical panes to their default sizes. These same commands are available from the Windows® View menu item.

## Conducting Spirometry Tests with the BP$^{D}$ Pneumotach

### FVC and MVV Tests

1. Access the FVC and MVV Configuration options and select Box for the Device.

2. Select FVC and MVV from the Spirometry option.

3. Have the filter and/or mouthpiece connected to the patient end of the pneumotach.

4. Attach a noseclip to the patient.

5. Leave the plethysmograph door open.

6. Conduct each of these tests and Review as described under their respective headings in the Spirometry section of the manual.

### PImax/PEmax Tests

1. Access the PImax/PEmax Configuration option and select Box for the Device.

2. Select PImax/PEmax from the Spirometry option.

3. Take a clean MIP-MEP mouth assembly with attached tubing and connect the free end of the tubing to the green pneumotach connector on the BP$^{D}$ arm.

4. Attach a large reusable mouthpiece, or an adapter and a pediatric mouthpiece, to the free end of the assembly. You may use a DC-2 filter if desired. Make any necessary changes in filter deadspace in PLETHYSMOGRAPHY configuration.

5. Attach a noseclip to the patient.

6. Leave the plethysmograph door open.

7. Conduct this test and Review as described under *PImax/PEmax* in the Spirometry section of the manual.

## SECTION SEVEN –THE REPORT DESIGNER (STANDARD PATIENT REPORTS)

**NOTE:**

The report option described in this section is the Standard Patient Report. To create reports with even more features and flexibility, refer to the next section, Extended Patient Reports.

### About Patient Reports

1. To configure a Standard Patient Report, from the GoTo menu, select *Report Designer*.

2. The patient report, or final report, is the summary of the results of a patient study and contains the Reported data selected from each study. The Report may be set up, or configured according to how you want it to present the patient information. Information that can be included in a patient report are as follows:

   **Text Area -** Usually reserved for the hospital or laboratory name and address or however else you wish to identify the report. This often comes as the top of the page, although report sections can be configured in any order on the page.

   **Demographic Information -** Reserved for information about the patient, that is, anything you may have entered in Patient Information: Name, age, weight, smoking status, etc.

   **Study Notes:** Information about the patient you may have entered in the Notes program, either the Technician's or the Physician's or both.

   **Challenge:** Results of FVC post-drug challenge testing, if such testing was conducted.

   **Interpretation:** How the results were interpreted by the selected Interpretation program (this will be either the Extended Ellis Interpretation program or a self-configured Interpretation program -- see Interpretation Editor for more details).

   **Tabular Data:** Numerical results, arranged according to desired test categories and parameters and columns within those categories.

   **Graphs:** Graphical results of the different types of tests.

   **Extended Fields:** Data from the Customized tabs and fields portion of the Patient Information screen.

   **Page Break:** Refers to inserting a page break at a desired location between sections in the report layout.

   **Trend Graph**: this option allows you to plot a maximum of six parameters from up to 50 studies from a single patient ID# for the purpose of observing trending patterns over time.

   **Trend Section:** Allows you to see trending data in tabular form.

3. In the Report program, each of these sections is configurable and may be arranged on the page in any order.

4. The format that the final report will take is referred to as the Report Definition You may configure more than one report definition and use each one according to particular data requirements. You select the

   final report definition you wish to use when you go to print the report. When you receive your PLUS system, some final reports are already configured for you.

5. Refer to *Report Definitions* to learn more about them.

6. Refer to *Creating Report Definitions* to learn how to create one.

## Report Definitions

1. A report definition is the style or format that you want your final patient report to take. It is composed of the various sections described above under *About Patient Reports*. You may configure each of these sections to your liking.

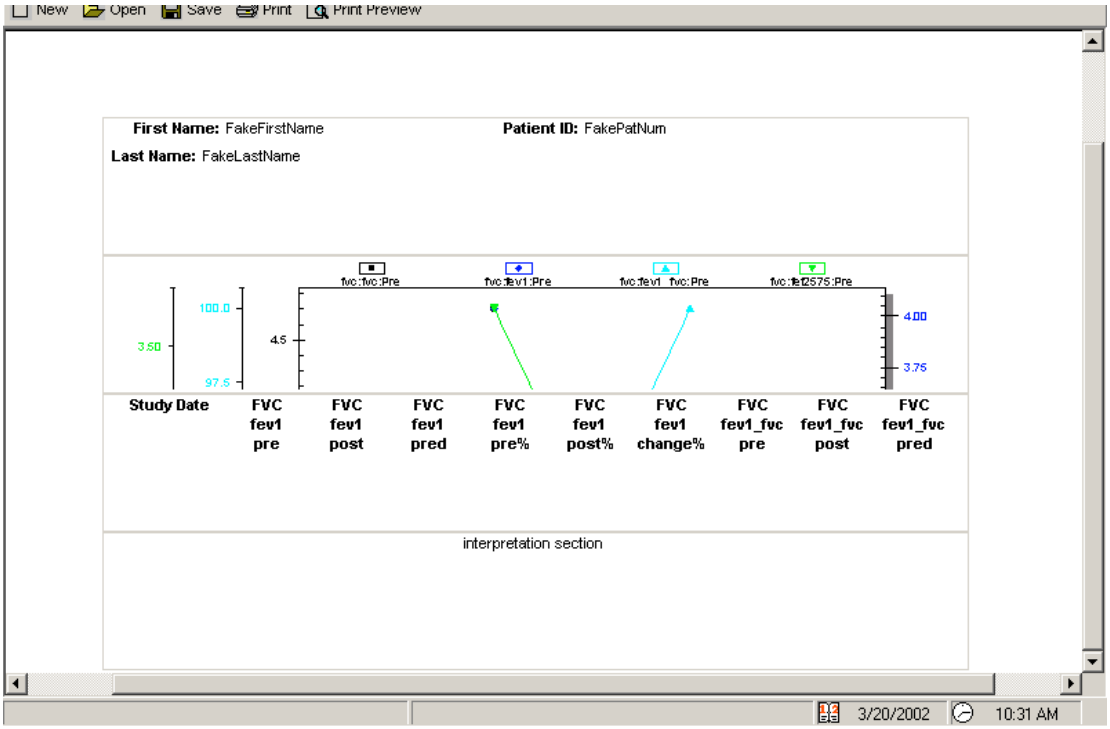



Figure 7-1. Sections Arranged in a Sample Report Definition

2. You may have several report definitions, some of which have features described in *About Patient Reports*, some of which have others.

3. Each report definition has a unique file name, for example short.frd, long.frd, standard.frd, challenge.frd. When you go to print a patient report, you select the desired report definition file from a list.

## Creating Report Definitions

1. Several report files are already defined for you when you receive the PLUS/2000 software. You may also define your own, as described in the following steps.

2. Select *Reports* from the Go To menu.

3. Click on the *File* option, then *New*.

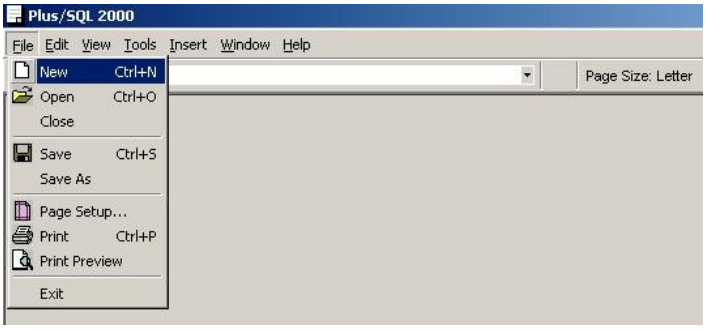



Figure 7-2. Selecting the *New* Report Option

4. The program will display a blank report file, for now called Untitled1.

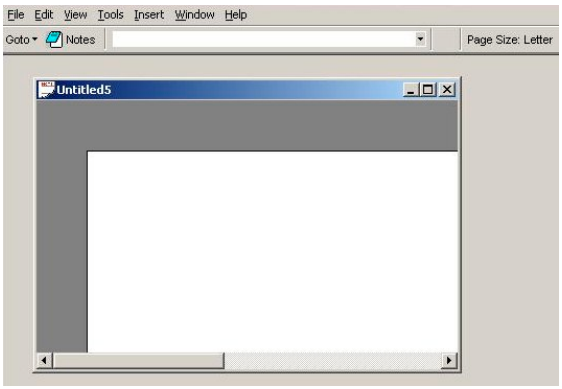



Figure 7-3. Opening a Blank Report File

5. To set up the report page, that is size, margins, orientation, etc., select *Page Setup* from the File menu.

6. To create a definition out of *Untitled1*, click on *Insert* from the top of the window. A menu of report sections to format will display as shown in the Figure below.

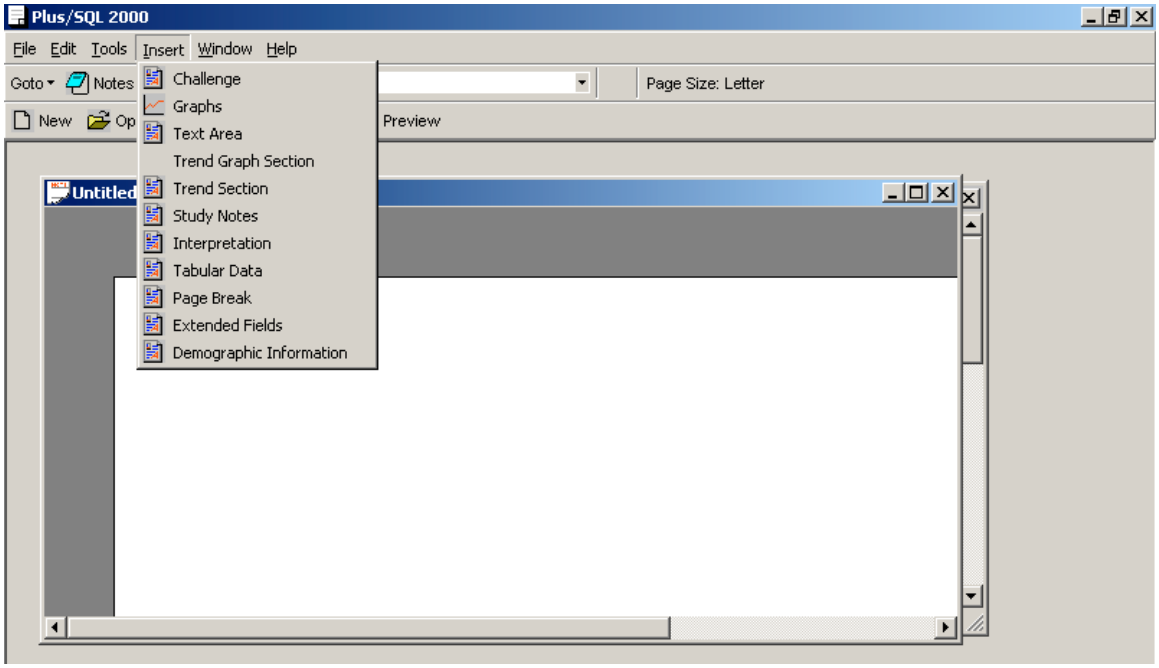



Figure 7-4. Report Insert Menu

7. In the following instructions, refer to the appropriate section titles from the *Insert* menu for details on defining each section.

8. When finished defining a section, click on *Close* and save the changes from the *File* menu.

9. You may have more than one of a particular type of section. Simply insert the section type twice.

10. In order to remove a section already created, click on it to get a broken outline. Then right-click and select *Delete Section*.

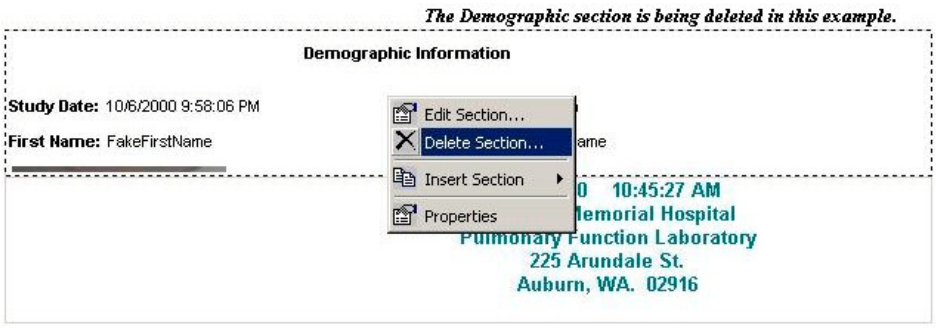



Figure 7-5. Deleting a Report Section

11. You may move a report section to any place on the page, provided it is contiguous with another section. Simply hold down the left mouse button on the particular section and drag it to the desired location.

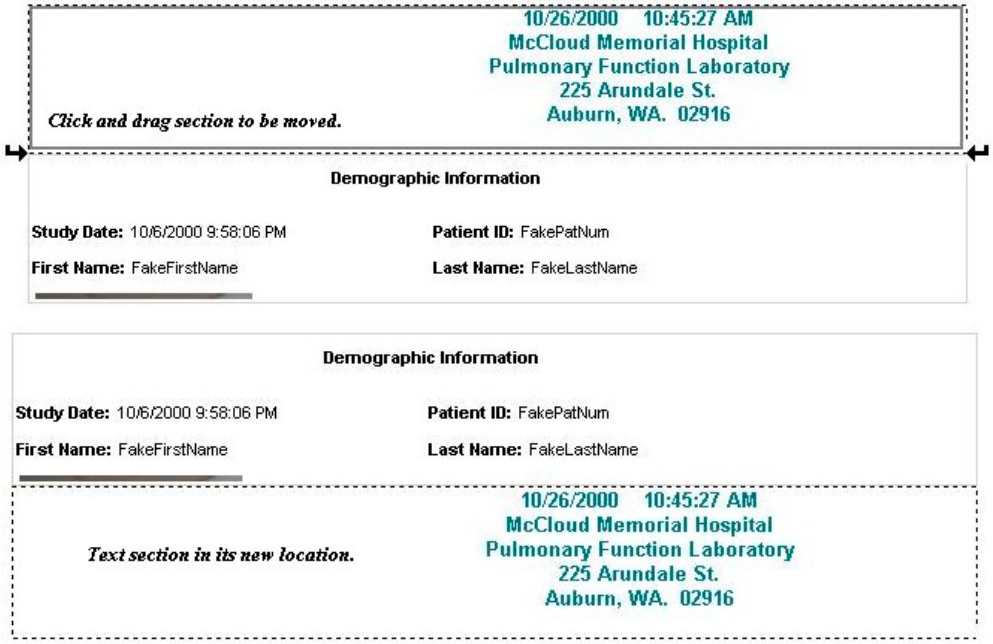



Figure 7-6. Moving a Report Section

12. You may have several report definitions open at once. Click on the desired report window to activate it and work on it. To open a new blank report, select *New* from the *File Menu* and a blank report window with a title such as *Untitled 2* will display.

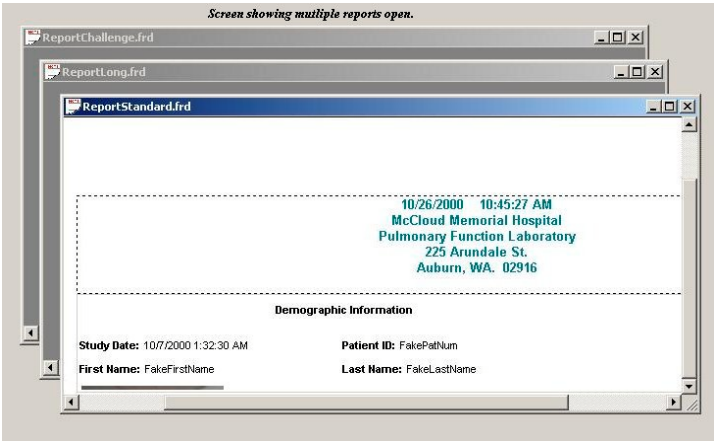



Figure 7-7. Several Report Definitions Open Simultaneously

13. In order to print a report, refer to *Printing a Report*.

**Text Section**

1. The Text Area of the report is usually reserved for the hospital or laboratory name and address or whatever else you choose to identify the report. This often comes as the top of the page, although report sections can be configured in any order on the page.

2. When the Report Sections Menu displays, click on Text Area. The text area window will display. This window is just like a standard Windows® text editor. For example, enter the name of your hospital at the cursor. Observe the tools at the top of the window for cutting, pasting, aligning text, creating different fonts and font styles.

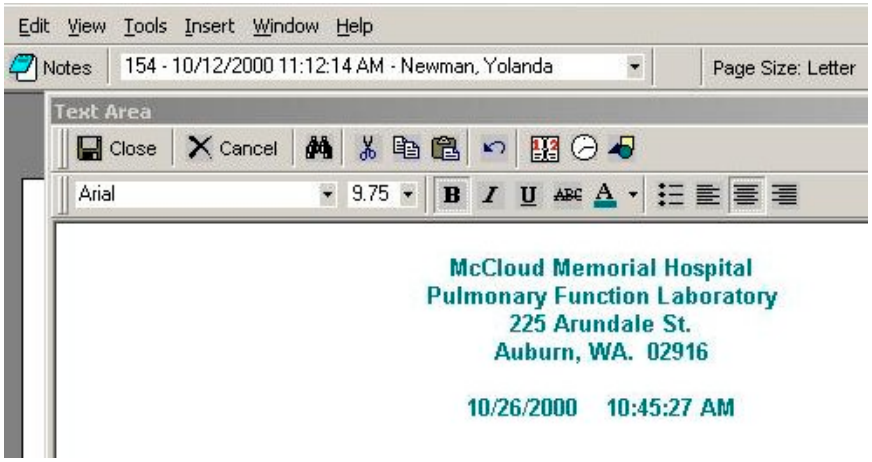



Figure 7-8. The Text Area Report Dialog

3. To automatically enter the current date and time, click on the *date* and *time* icons at the top of the window at the place in the text where you want them inserted. To insert a photo of the patient or any other subject, click on the *image* icon and select an image file.

4. To search for a word or phrase in an extensive text, click on the *Find* icon (binoculars).

5. To undo an edit just created, click the *Undo* arrow.

6. Click *Cancel* if you wish to abandon your work without saving the changes.

7. When the text appears as you want it, click *Close*. The program will display the text in an abbreviated spot on the report screen. Select *Save* As from the file menu and name your report definition as you save it. The .frd extension will be added to the filename.

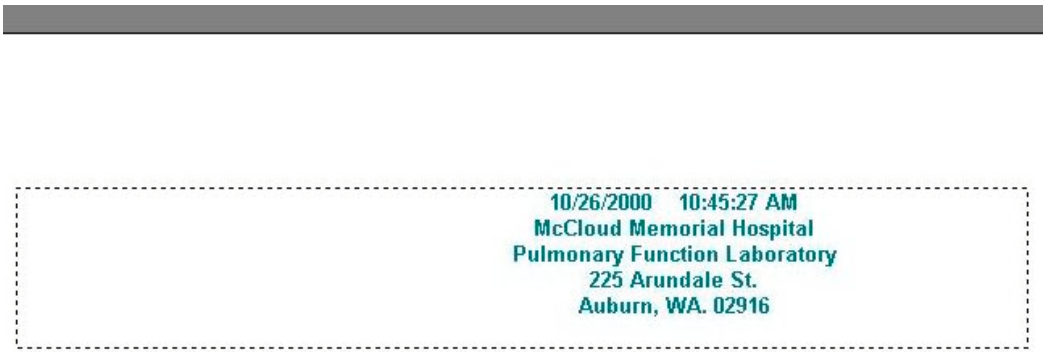



Figure 7-9. Sample Text Section in a Report Definition

8. If other sections of the report already exist, you may move the text section with respect to the others by holding down the left mouse button and dragging the section to where you want it.

9. If you wish to add the text section or any section to a report that already exists, refer to *Making Changes to a Report Definition.*

**Demographic Information Section**

1. The Demographic Information section of a report contains the type of information entered in the Patient Information program. In the Report program, you can drag and drop the various information fields to place them where you want on the report page.

2. From the Reports Sections Menu, select Demographic Information. The list of available fields will display on the left pane. The blank report page will display on the right.

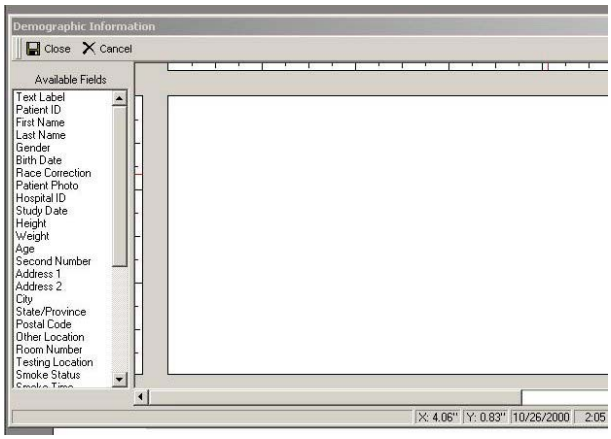



Figure 7-10. The Demographic Report Dialog

3. To scroll the list of available fields, use the arrows or the scroll bar. Click on the desired field, for example, *Last Name*. Holding down the left mouse button, drag this field over to the spot you want it to occupy on the report page.

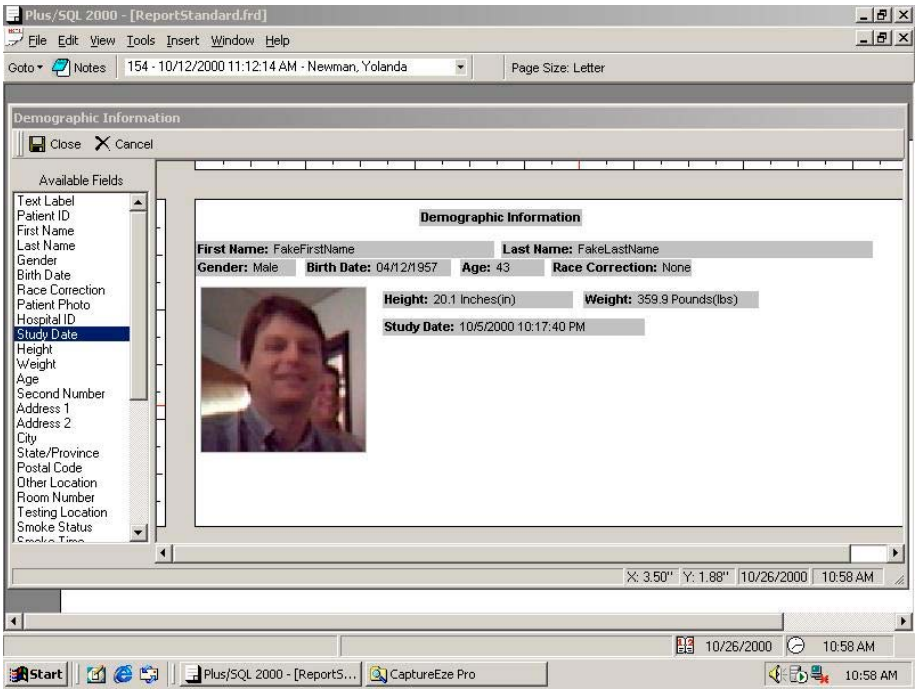



Figure 7-11. Arranging Fields in the Reports Demographic Section

4. The amount of space occupied by the selected field will be represented by the gray bar and will be occupied with filler, rather than real, data. If you try to drag another field next to it and the combined fields occupy more space than is on the line, the program will not allow you to place the new field on the same line.

5. The rulers along the top and side of the text area will show you how much actual space your information takes up. The rulers are marked in $^{1}/_{2}$-inch increments. The coordinates of the cursor marking your place on the page will be displayed by red marks on the rulers.

6. Once you have the desired field in the workspace, you may drag it to another position on the page by simply pointing to it and holding down the left mouse button.

7. Continue dragging and dropping fields until the Demographics section is configured as you want it. Then click on *Close*. An abbreviated form of the Demographics section where appear on the screen where you have inserted it.

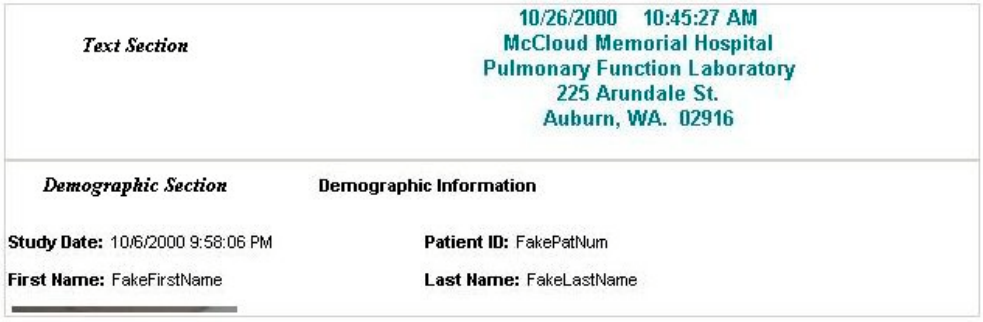



Figure 7-12. Sample Demographic Section in a Report Definition

8. The field, Text Label, allows you to enter Information of whatever type you want, such as a title for the demographics section. When you click and drag Text Label, the program displays a Properties box. Enter the desired label and click on whether you want it to be in Title font style (boldface) or Body font style (normal type).

9. If after placing a field, you decide you don't want it, simply drag it back to the list on the left pane.

**Tabular Data Section**

1. To define a Tabular Data section in a final report definition, select Tabular Data from the Report Sections Menu. The program will display a window with various types of properties to select.

2. First click on the down arrow to display the test types. Click on the desired test type, for example, Forced Vital Capacity.

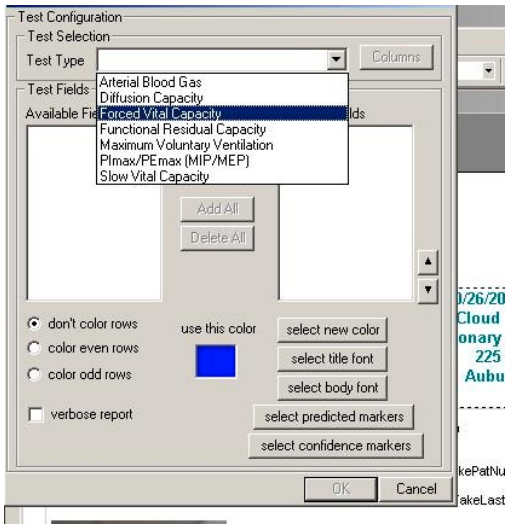



Figure 7-13. The Tabular Report Dialog

3. In the Available Fields box, the selectable parameters for Forced Vital Capacity will display. Click *Add All* if you wish all available parameters to display on the report. To select one individually, highlight it and click *Add*. The selected parameters will display in the Selected Fields box.

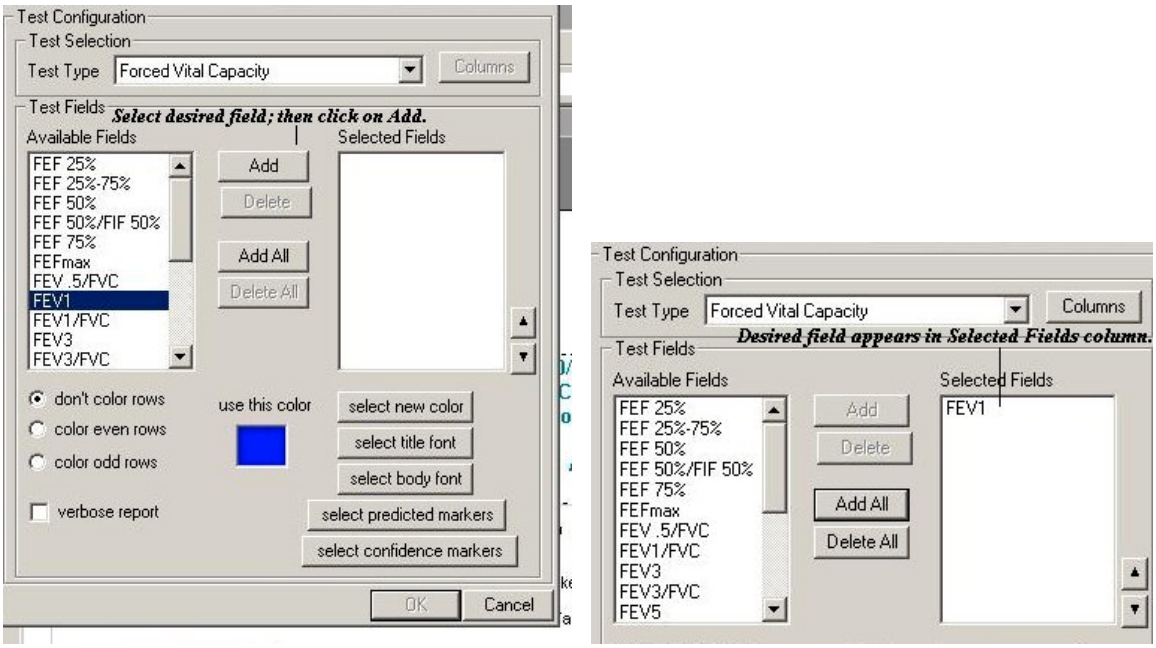



Figure 7-14. Selecting a Field for the Tabular Report

4. To delete a single parameter from Selected Fields, highlight it and click the *Delete* button. To delete all of them from Selected Fields, click the *Delete All* button.

5. When you have selected the desired fields, click on *Columns* to set up the type of headings in the report definition. The program will display a window with the available column headings on the left and the workspace with the selected fields on the right. A ruler across the top provides a guideline for placement of the columns.

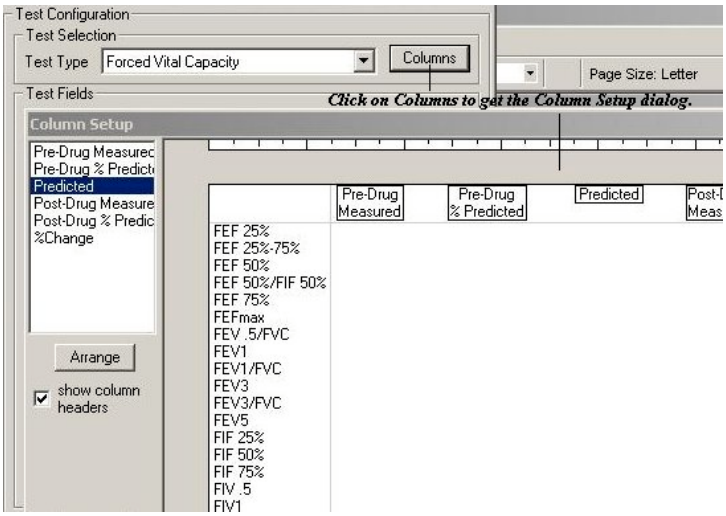



Figure 7-15. Assigning Column Headings in the Tabular Report

6. Drag the desired column headings to their designated areas by pointing to the heading and holding down the left mouse button. Click the Arrange button to space them evenly. Click on Show Column Headers if you want the headings to show on the actual report.

7. When done with Column Setup, click OK. The program will return to the Tabular Configuration window.

8. You have the option of coloring alternate rows in the reports for improved reading ability. Select one of the following:

*Don't Color Rows*
*Color Odd Rows*
*Color Even Rows*

9. The default row color will display in a box to the right. To change this color, click on Select New Color. The standard Windows® color-changing dialog will display. Change the color accordingly.

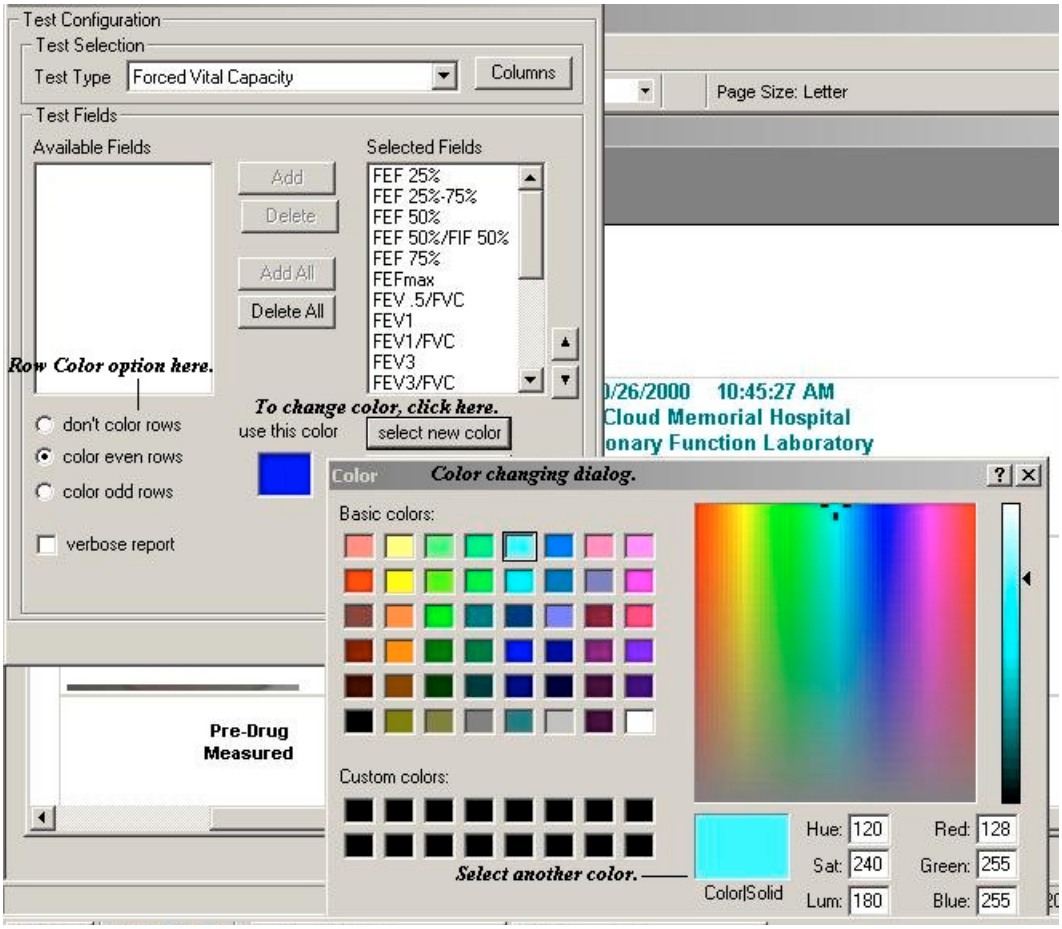



Figure 7-16. Selecting a Row Color in the Tabular Report

10. Click on Verbose report if you want the detailed form. Unclick it if you want the abbreviated form.

11. *Select Title Font* allows you to change the font of the column headings and parameters. *Select Body Font* allows you to change the font of the data reported. Both are standard Windows® font changing dialogs.

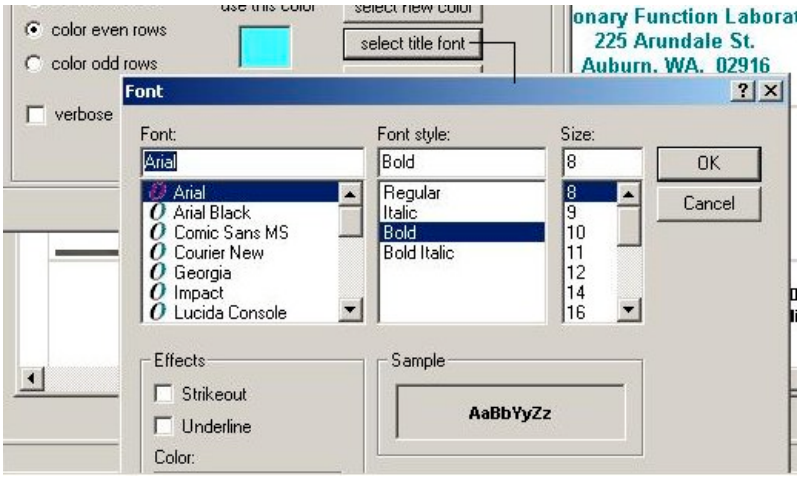



Figure 7-17. Selecting Fonts for the Tabular Report

12. To configure predicted markers, click on *Select Predicted Markers*. This option allows you to identify a row by color if the percentage of predicted is either below or above an amount you indicate.

13. To mark a row that is below a certain percentage of predicted, click on *Use a Low Value Marker*. Enter the amount of percent predicted below which the row should be marked.

14. Click the box if you wish to use the < symbol in the row to signify less than the indicated amount. Click the box to use the default color, which the row will appear in if less than the indicated amount. To change the color, click on Select New Color. A standard Windows® color-changing dialog will display. You may choose to use either a symbol or color or both.

15. Do the same for the high value marker. Click on the box to use one. Enter the amount of percent predicted above which the row should be marked. Click the box if you wish to use the > symbol in the row to signify greater than the indicated amount. Click the box to use the default color, which the row will appear in if greater than the indicated amount. To change the color, click on Select New Color. Click OK to return to the Tabular Configuration menu.

16. If you wish to have Confidence Interval markers on your report, back at the Tabular Configuration menu, click on *Select Confidence Markers*.

17. Click on the first section if you want the report to indicate by marking the row that a value is greater than the upper limit of normal. Enter the desired character used to indicate this, for example, <. Check the box in order to use this symbol. Check the next box if you wish to use a color to symbolize this. Click Select New Color to change the color. You may use a symbol and/or a color.

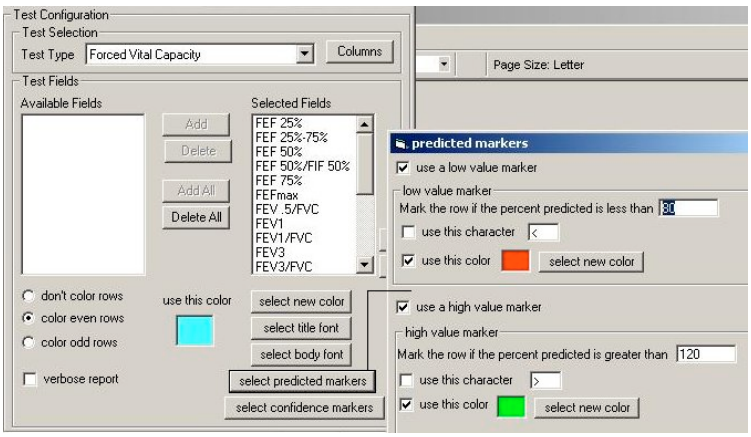



Figure 7-18. Selecting Predicted Markers in the Final Report

18. Do the same for the Lower Limit of Normal and for the Normal Range. In other words, enter the symbol and/or color to use to indicate rows with values within the normal range.

19. Back at the Tabular Data dialog, select another test type and follow the instructions here again. Do so for as many tests as you want data reported for.

20. When done with Tabular Data configuration, click OK. You will see a sample portion of your tabular section on your report definition screen.

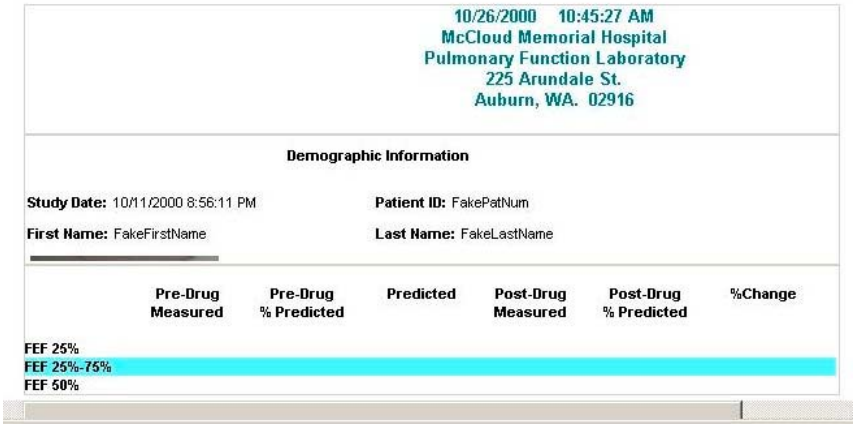



Figure 7-19. Sample Tabular Data Section in a Report Definition

21. Click *File* and *Save* to save the latest changes.

### Graph Section

1. To configure a graph section in a final report definition, select *Graph* from the Report Insert menu. The program will display a window with icons of the available graph types on the left and a workspace on the right.

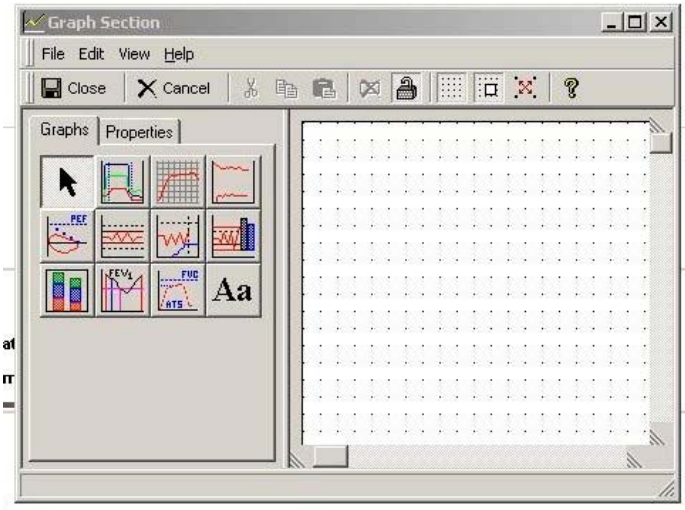



Figure 7-20. The Graph Report Dialog

2. Defining the graph section is a matter of placing the graph icons where you want them on the workspace and then sizing and arranging them. Once you have placed a graph, the Properties tab on the left pane allows you to specify certain characteristics of the graph.

3. Hold the pointer over a graph icon; the program will display the test type. For example, holding the cursor over the FVC graph will display the words *Flow Volume*.

4. Click on the icon to select it. Then move the pointer to the desired location on the workspace. You will see the cross cursor appear.

5. Holding the left cursor down, draw the FVC graph in the size you want it by dragging the mouse diagonally. This type of maneuver is known as click and draw.

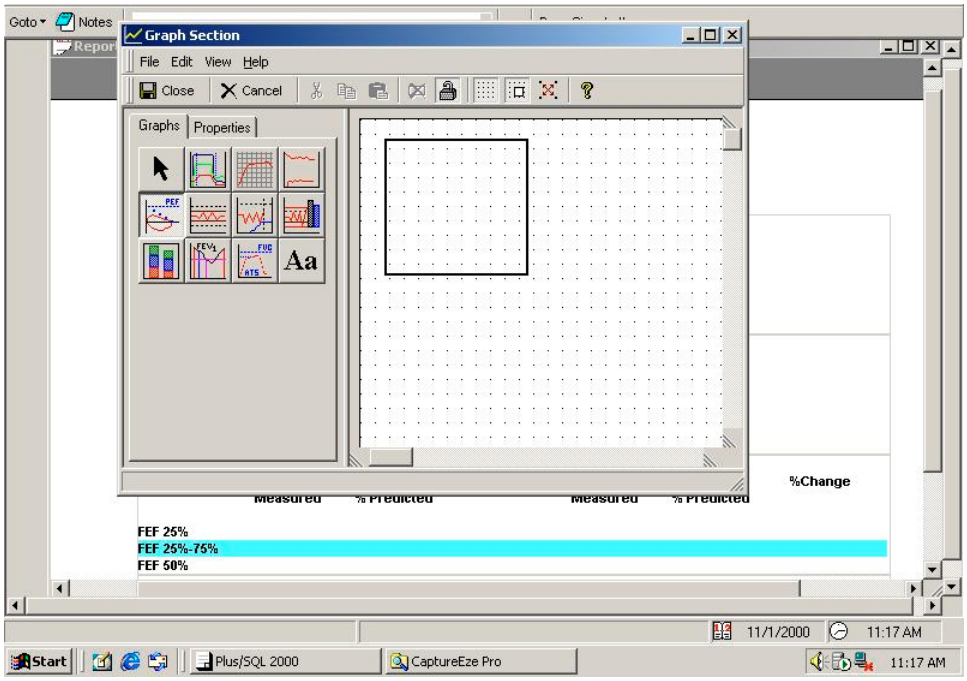



Figure 7-21. Placing a Graph in a Report Definition

6. To size the graph after drawing it, click on it to select it and then drag one of the solid box handles.

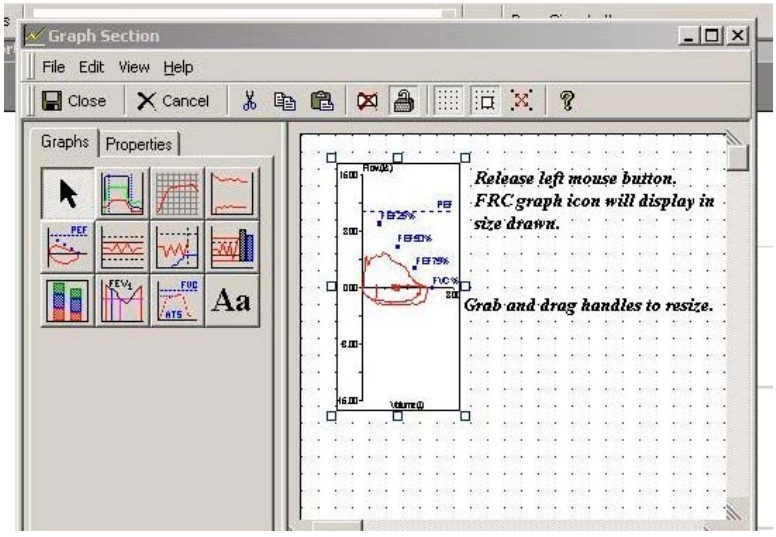



Figure 7-22. Sizing Graphs in a Report Definition

7. The toolbox at the top of the graph definition window contains the following functions:

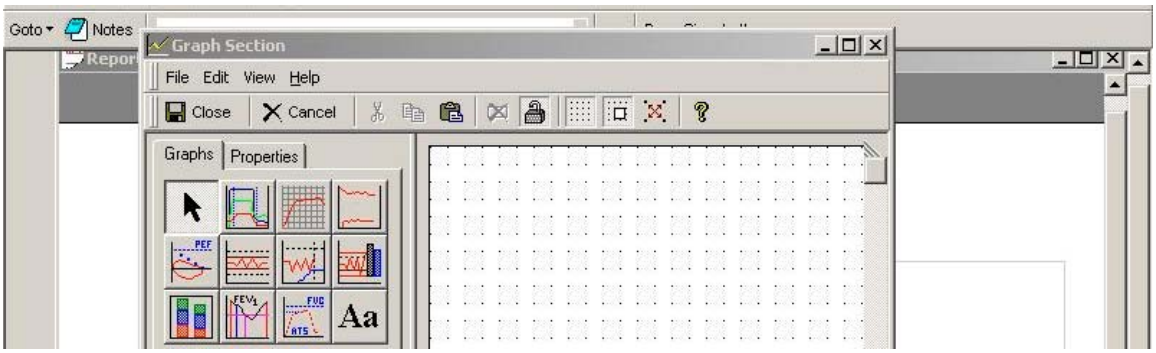



Figure 7-23. The Graph Report Toolbox

**Cut:** Click on Graph in workspace to select it. Click on Cut to remove the graph from the workspace and hold it on the Clipboard for further use.

**Copy:** Select graph. Click on Copy to make another copy of graph to hold on Clipboard while still retaining graph in workspace.

**Paste:** Allows you to place a graph either cut or copied to Clipboard at upper left corner of graph. You can then drag the graph to the desired location on the grid.

**Delete:** Allows you to completely delete the selected graph from the workspace and retains no copy on the clipboard.

**Lock:** Clicking on this option prevents you from moving or sizing the graph. Select this if you wish to avoid inadvertently changing the size or location of your graph.

**Grid:** Allows you to select or deselect the grid feature. Without this feature there is no grid on the workspace to help align the graphs.

**Snap-to Grid:** With this feature selected, when you move your graph, it will align itself with the closest grid lines. Without this feature selected, you may move the edges of the graph to points between grid lines.

**Grid Size:** Allows you to change the spacing of the grid markers.

**NOTE:**
The above features are also available from the *Edit* and *View* menus.

8. To define graph properties, click on the graph to select it; then click on the Properties tab.

**NOTE:**
At this time, not all properties apply to all graphs, but are present for the purposes of future expansion.

9. On the first line, *Name*, the program will display a drop-down list of the particular FVC graphs if more than one was drawn (FV-1, FV-2, etc.). Click on the name of the graph whose properties you wish to define.

10. Following is a description of the type of entry required for each line:
**Name:** name of graph
**Left:** location on workspace of left boundary
**Top:** location on workspace of top boundary
**Height:** graph height
**Width:** graph width
**Border Style:** outside border of graph (None/Solid/Dash/Dot)
**Graph Type:** Pre-Drug/Post-Drug/Pre-Post Overlay

**Back Color:** Background color of graph
**Predicted Color:** color of predicted markers
**Pre Color:** color of pre-drug tracing
**Post-Drug color:** color of post-drug tracing
**Font:** font used on graph

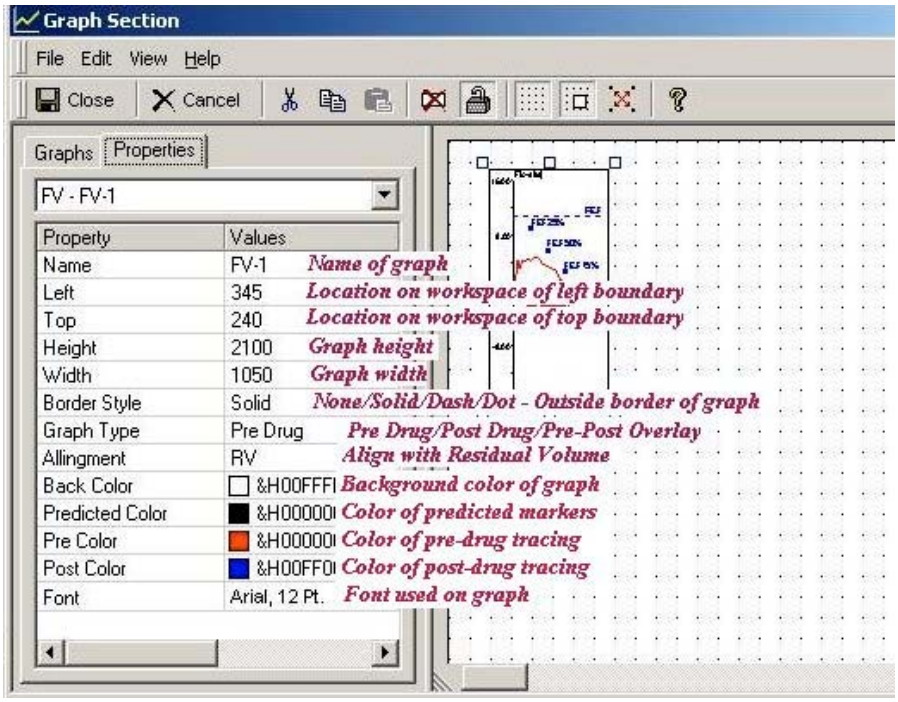



Figure 7-24. Defining Graph Properties in a Report Definition

11. To change the size of either of these columns for better viewing, place the pointer over the middle line in the Properties/Values row until you see the double cursor arrow. Then hold down the left mouse button and drag the middle line left or right.

12. Note the following:

    The properties **Left** and **Top** change as you move the graph on the workspace. Also, you can move the location of the graph on the workspace by typing in different property values.
    As you change the size of the graph in the workspace, the **Height** and **Width** values will change. Also, when you change the height and width values, the size of the graph in the workspace will change.
    To change the **Colors** offered, double click on the box and a standard Windows® color changing dialog will display.
    To change the **Font**, double click on the font offered and a standard Windows® font changing dialog will display.
    The categories under **Graph Type** refer to whether you want a Pre-drug tracing, a Post-drug tracing, or Pre- and Post-drug tracings overlaid in different colors on a single graph.

13. When through reviewing and modifying properties to a graph, you may click on the Graphs tab and repeat the above procedure to draw and define another graph.
14. Following are properties pertaining to particular graphs:

The **Arrow** icon indicates that the pointer used to move and size the graphs is active.

**Aa** is for creating text blocks. You would draw this block on the workspace if you wanted to add a caption to a graph for instance. It has the following additional properties:
**Back Color:** The background Color

**Fore Color:** The print color
**Caption**: Enter in the desired caption for the text block here.
**Alignment:** Right/Left/Center - Use this to align the caption within the block.
**Wrap:** Select this if you want text that is too long for a line to wrap around to the next line.

**DL Graph:**
**Test Type:** Allows you to choose between a normal test and washout.
**Colors:** Allows you to change colors for the Volume, CO and CH4 tracings.

**Disability Graph:**
The disability graph is for the diffusion and FVC tests. This can be the only graph in the section, as it has to be large enough to view for hand calculations or for Social Security Disability evaluations. If you attempt to place another graph on the screen as well, a message will inform you of such. Note that no matter how large or small you draw this graph, it will occupy the full screen. If you want both a diffusion and an FVC disability graph in the report, you would need to create two graph sections, one for each of them.

**Test Type: DL/FVC** - Allows you to choose either one of these tests for the disability graph.

**FRC Graph:**
**L1 -** Allows you to change the color of the tracing representing the patient's end-tidal points.
**L2 -** Allows you to change the color of the tracing representing the helium meter reading.

**Flow Volume Graph (of the FVC Maneuver)**
**Alignment: RV/Body Box -** RV refers to an FVC done on the CPL spirometry equipment. Body Box refers to an FVC test done on the Body Plethysmograph.

**MIP/MEP Graph:**
**Pressure Color -** Allows you to change the color of the pressure tracing.
**Min/Max Pressure Color -** Allows you to change the color of the lines representing minimum and maximum pressures.
**Predicted Color -** Allows you to change the color of the dotted lines representing the predicted minimum and maximum pressures.

**MVV Graph:**
**Volume Color -** Allows you to change the color of the patient's volume tracing.
**Accumulated Volume Color -** Allow you to change the color of the patient's cumulative volume tracing.

**SVC Graph:**
**Plot Color -** Allows you to change the color of the SVC tracing
**Best Color -** Allows you to change the color of the lines representing the baseline inspiratory and expiratory points and the maximum inspiratory and expiratory points.

**Bar Graph:**

The bar graph shows the relationship between various lung volumes and capacities and offers bar color options for the parameters RV, ERV, and IC.

**Data Source -** Indicates whether the data was taken from a helium dilution FRC on the CPL or from a body plethysmograph lung volumes test.

**Challenge Graph:**

**Control Color:** The color of the data point representing the Control effort.
**Pre-Drug Color:** The color of the data point representing the Pre-drug effort.
**Reversal Color:** The color of the data point for the effort at which the reversal agent was given.
**Datapoint Color:** The color of all other data points.
**Percent Change Color:** The color of the data point representing the effort at which the indicated percent change was observed.
**Line Style: Solid/Dot/Dash/Dot-Dash -** The style of the tracing depicting the tests composing the overall challenge test.
**Parameter: FVC/FEV1/FEF25-75/FEFmax -** The parameter selected for tracking in which to observe the indicated percent change.
**Percent Change (10-50 in 5% increments) -** The percentage change specified for the desired parameter during the series of challenge tests. For example, PD 20 for FVC would refer to a 20-percent drop in FVC.

**Volume Time Graph (of the FVC Maneuver)**

The properties for this graph have been explained in other graph sections.

**Body Box Volume Graph**

**Plot Color:** Refers to the color of the Volume-Time tracing.
**Test Line Color:** Refers to the broken vertical lines dividing test phases.
**Result Line Color:** Refers to the broken horizontal lines showing lung volumes.

**Body Box Composite Graph**

**VTG Plot Color:** Refers to the color of the VTG tracing.
**RAW Plot Color:** Refers to the color of the RAW tracing.
**Tangent Line Color:** Refers to the color of the broken tangent line drawn through the tracings.
**0.5 Limit Line Color:** Refers to the horizontal broken lines between which the Raw maneuver was conducted.

15. When finished drawing and arranging graphs on the workspace and specifying their properties, click on the Close button. Save the Graph section for your Report Definition from the File menu.

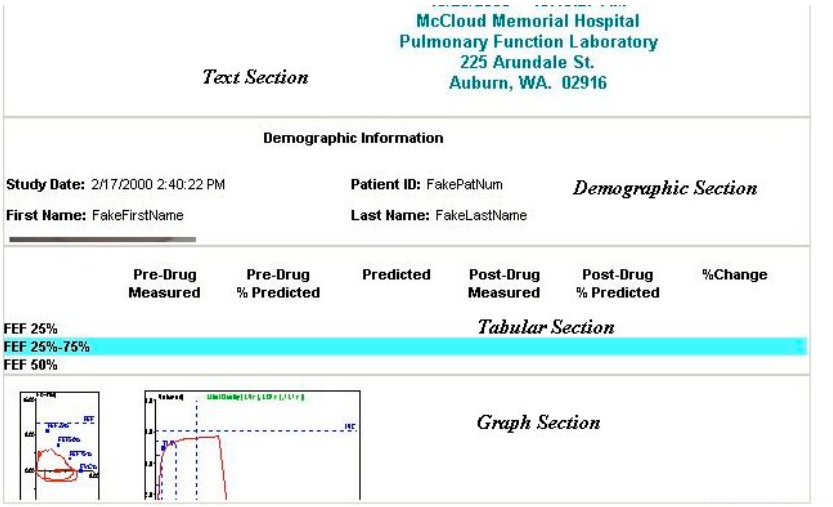



Figure 7-25. Sample Graph Section in a Report Definition

**Challenge Section**

1. This option allows you to configure the Challenge report section of the report definition. While in Reports (Go To/Reports), select *Insert*, then *Challenge*.

2. The workspace for the challenge report setup will display on the right. The column headings will display on the left. Drag each desired heading onto the desired location on the workspace by pointing to it and holding down the left mouse button.

3. If you wish to remove a column heading, select it by clicking on it, then on the *Delete Selected Column* button.

4. Click the *Arrange* button to space your columns evenly.

5. Click on *Options* to change the heading font and the data font. If you wish to highlight the comparison row, that is, the percentage of baseline row, click on this box. Click on Change Color to change the highlight color.

6. When done, click OK to return to the sample report screen.

**NOTE:**
In order to create a Challenge protocol, refer to The FVC Challenge Editor in *Section Three -- Configuration*.

**Interpretation Section**

1. Select this option to insert the results of the automatic Interpretation program into the report. While in the reports program, (GO TO/Reports), click *Insert*, then *Interpretation*.

2. The program will give you a choice between the PLUS program's automatic interpretation program, which is the Extended Ellis program, and any additional interpretation programs you may have created in the Interpretation Editor (see Section Three – Configuration).

3. You may also change the font of the resulting interpretation report. The standard Windows® font-changing dialog will display.

4. When you have made your selection, click OK and the program will indicate the Interpretation program section on the sample form.

**Study Notes Section**

1. The study notes section will contain the Technician or Physician notes entered in the Notes program.

2. When in the Reports program (Go to/Reports), click *Insert*, then *Study Notes*. The program will ask you if you wish to report technician notes or physician notes. Click next to the desired option; then click OK.

3. The screen will show a box without the actual notes in them but with the title Technician Notes or Physician Notes. The actual notes will display when you preview the report in the Print program.

4. To enter both Physician and Technician Notes, you must enter them as two separate Notes sections.

**Page Break Option**

1. In order to insert a page break after a particular section, insert the cursor on that section. Then click on *Page Break*.

2. To delete a page break, highlight the page break section, right-click and select *Delete*.

**Extended Fields Section**

1. To add the Custom Tabs and Fields section from the Patient Information option, select Extended Fields. The following menu will display:

   *Show Custom Fields*
   *Show Imported Fields*
   *Show Both*

2. Custom Fields refers to the Custom tabs and fields you have created on your own PLUS 2000 system. Imported Fields refers to the Custom tabs and fields present on any study you have imported from another PLUS 2000 system, if these differ from your own.

3. If you wish to show both your own custom fields and those of any imported studies, click on Show Both.

**Trend Section**

1. To indicate the parameters (up to six) you wish to see listed for trending purposes on the Final Report, click on *Trend Section*.

2. The program will display a dialog that allows you to select the test type, the parameters for that test, and the context (Pre-Measured, Post Predicted, % Change, etc.).

3. For example, in the Test Type box, click on FVC. In the Available Fields box, the available parameters for the FVC test will display. Click on the desired parameter. In the Context box, click on the desired context. When all three selections have been made, click on the right-facing arrow to enter the entire parameter, e.g., *FVC:fev1:pre* into the Selected Fields box.

4. If you wish to remove a parameter from the *Selected Fields* box, click on the left-facing arrow.

5. Repeat this series of steps for as many test parameters as you wish.

6. When finished selecting the desired parameters, click on OK. The program will indicate the Trend section on the sample form.

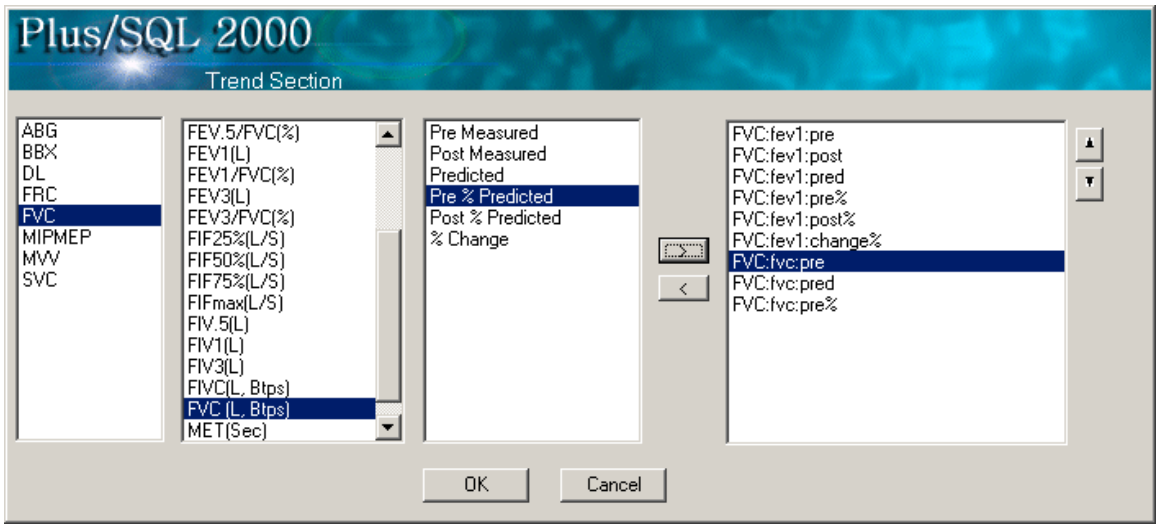



Figure 7-26. The Field Selection Dialog for the Tabular Trend Report Section

**Trend Graph Section**

1. To indicate the parameters (up to six) you wish to see plotted in graphical form for trending purposes on the Final Report, click on Trend Graph Section.

2. The program will display the Field Selection dialog, which allows you to select the test type, the parameters for that test, and the context (Pre, Post, % Change, etc.).

3. For example, click on the down arrow in the Test Type box to view the available test types. Click on FVC to select this as a test type. In the Available Fields box, the available parameters for the FVC test will display. Click on the desired parameter. In the Context box, click on the desired context. When all three selections have been made, click on the right-facing arrow to enter the entire parameter, e.g., *FVC:fev1:pre* into the Selected Fields box.

4. If you wish to remove a parameter from the final selections box, click on the left-facing arrow.

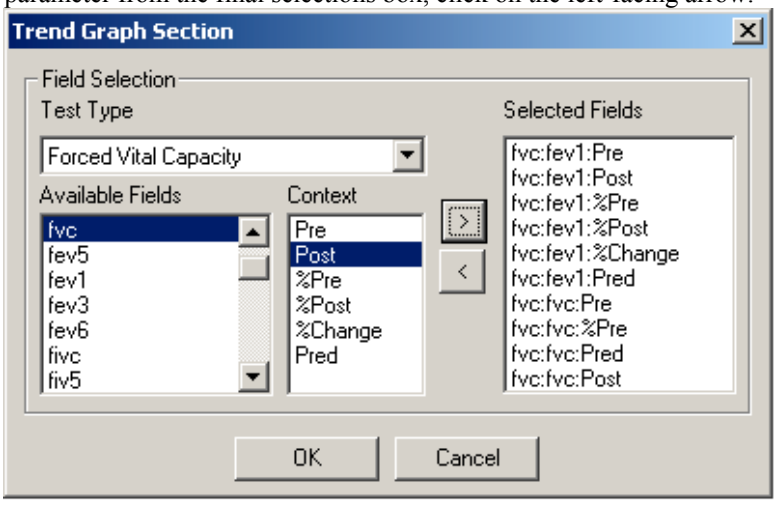



Figure 7-27. The Field Selection Dialog for the Graphical Trend Report Section

5. Repeat this series of steps for as many test parameters as you wish.

6. When finished selecting the desired parameters, click on OK. The program will indicate the Trend Graph section on the sample form.

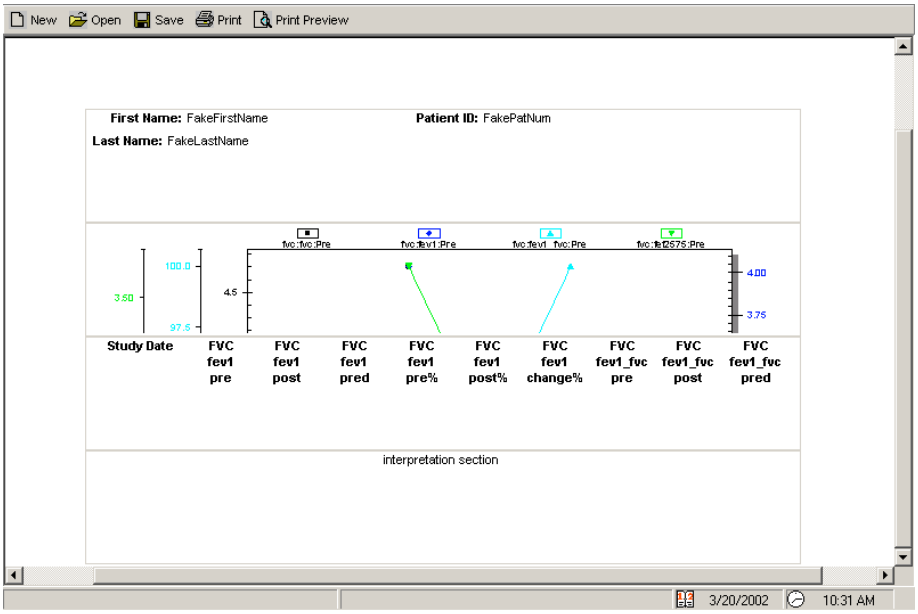



Figure 7-28. Sample Trend Section in a Report Definition

## Making Changes to a Report Definition

1. In order to make changes to an existing report definition, first select *Go To*, then *Reports*. Select the *File* option, then *Open*. A standard Windows® file search window will display. Search for the desired report definition file (all report definition files have extension .frd) and select it.

Figure 7-29. Selecting a Final Report Definition

2. The report file will display the abbreviated sections for the report definition. Double click on the desired section to bring it up, or click on the section to get a broken line and select *Edit Section* from the right-click menu. Then simply make changes as described in the topics for each section.

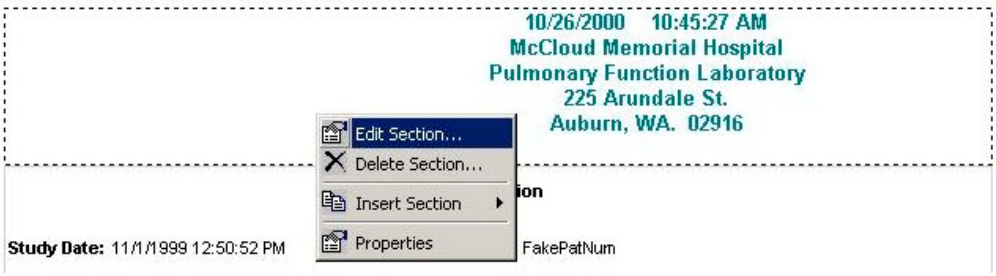



Figure 7-30. Editing a Section of the Final Report

3. When finished making changes to a section, click Close and then save the changes from the File menu.

### Saving and Exiting the Report Program

1. When you are finished composing a report definition, click on File, then Save.

2. Assign a name to the new definition. The .frd extension will be automatically appended to it.

## Printing Reports

1. To print a report, click on *File*, then *Print Report*.

2. A default report file, as designated in General Configuration, should display in the Report Generator window next to *Selected Report*.

3. If no report displays, or if you want to change the current report definition, click on the dotted button next to the bar. A standard Windows® file search window will display.

4. Click on the down-arrow for *Files of Type*. The following options will display:

   **Report Definitions (*.frd,*.xrd) -** Selecting this option will display the available report files for Standard report (*.frd) and Extended (*.xrd) report definitions. The Standard report refers to definitions created in *Report Designer,* on the GoTo menu.
   **Final Report Definitions (*.frd)** - This option refers to the type of report defined in *Report Designer* on the GoTo menu.
   **Extended Report Definitions (*.xrd)** - This option refers to the type of report defined in *Extended Reports* on the GoTo menu.
   **All Files (*.*)** - Selecting this option will display all files in this folder.

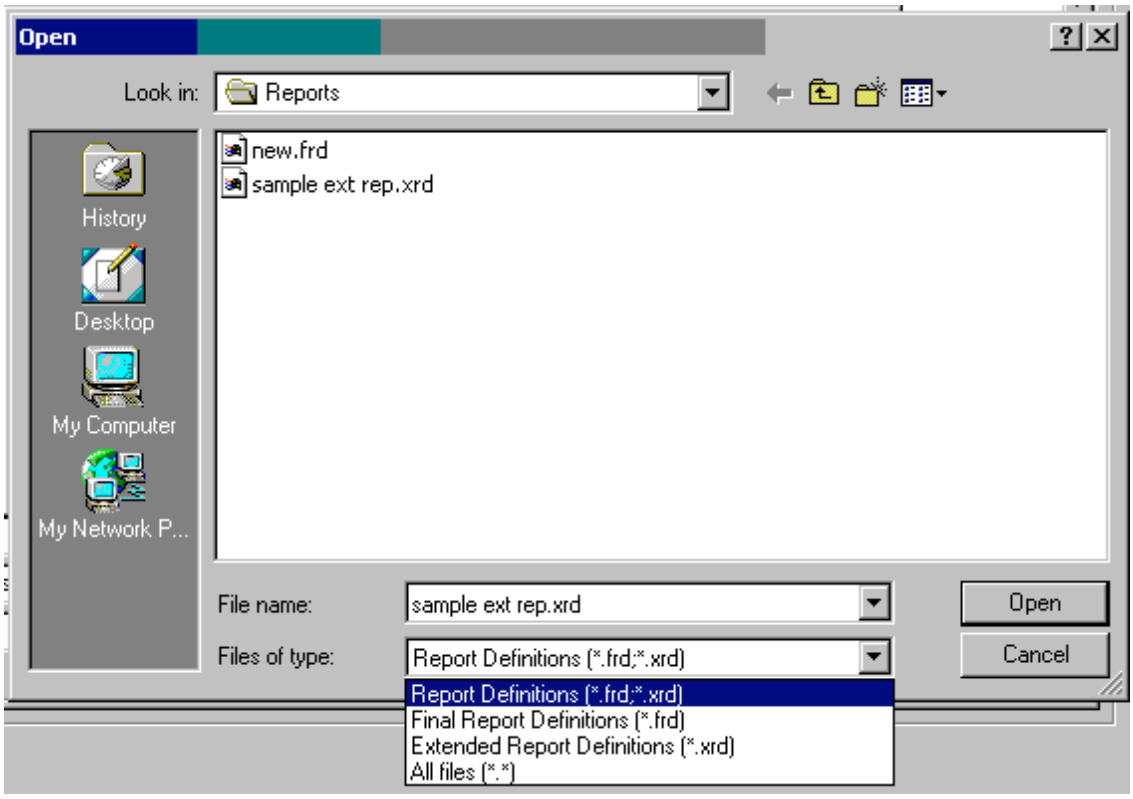



Figure 7-92. Selecting the Type of Report to Print

5. Select the desired file type and search for the desired report files. Report files are normally stored in C:\Program Files\Collins Medical\Plus2000\Reports.

6. Double-click on the desired report file; this file name will now display as the selected Report definition in the Report Generator.

7. Now that you have selected a report definition, you must select a patient study or studies to print.

8. The patients currently listed in your Patient Cache will display in the window. If you want reports to print for all of these patients in automatic succession, click on *Select All*. Checkmarks will appear in the boxes next to all the patient studies.

9. If you wish to print reports on a select number of patients or just one, click on the desired boxes to select them. Click again to de-select a study if you change your mind.

10. You may click on Preview to preview the report for the highlighted study on the screen before printing it.

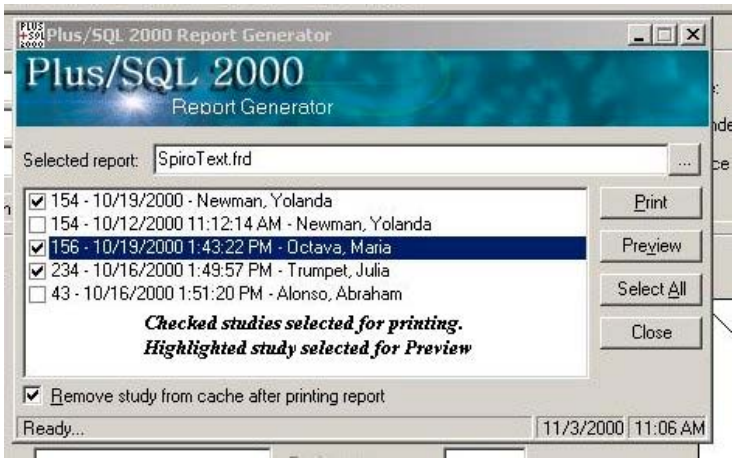



Figure 7-x. Selecting a Report Definition for Printing

11. When ready to print, click on Print.

12. In General Configuration you may select a default final report to print. This is the report that will print unless otherwise selected at printing time.

# SECTION EIGHT – EXTENDED PATIENT REPORTS

## About the Extended Reports Option

1. In addition to the standard final report configuration (in the option *Report Designer*) described in Section Seven, there is an Extended Report option. *Extended Reports* is a complete WYSIWYG (what you see is what you get) report editing package designed to extend the capabilities of the standard Final Report option (listed on the GoTo menu as the *Report Designer*) and to provide additional reporting functionality.

2. The Extended Report option consists of *report sections* (such as Demographics, Study Notes, Tabular Data, etc.) that you select and manipulate as rectangular objects on a page using the *report editor*. You can add, delete, size, copy, cut, paste, etc. any number of each section to create and customize a report, on a page-by-page basis. You may create sections side-by-side on the page. You can also add and delete pages from the report.

3. Before creating an Extended Report, refer to Figures 8-1 and 8-2, which show one of the preconfigured reports that come with the PLUS program. Figure 8-1 shows this report in Setup mode. Figure 8-2 shows a portion of the same report in Preview mode, where you see the actual data for the current patient.

4. To use one of the preconfigured extended reports without creating a new one, select *GoTo, Extended Reports, File* and *Open.* An extended report file will have an .xrd extension, whereas the standard reports will have an .frd extension.

5. To set up a brand new extended report, proceed to the instructions following Figures 8-1 and 8-2.

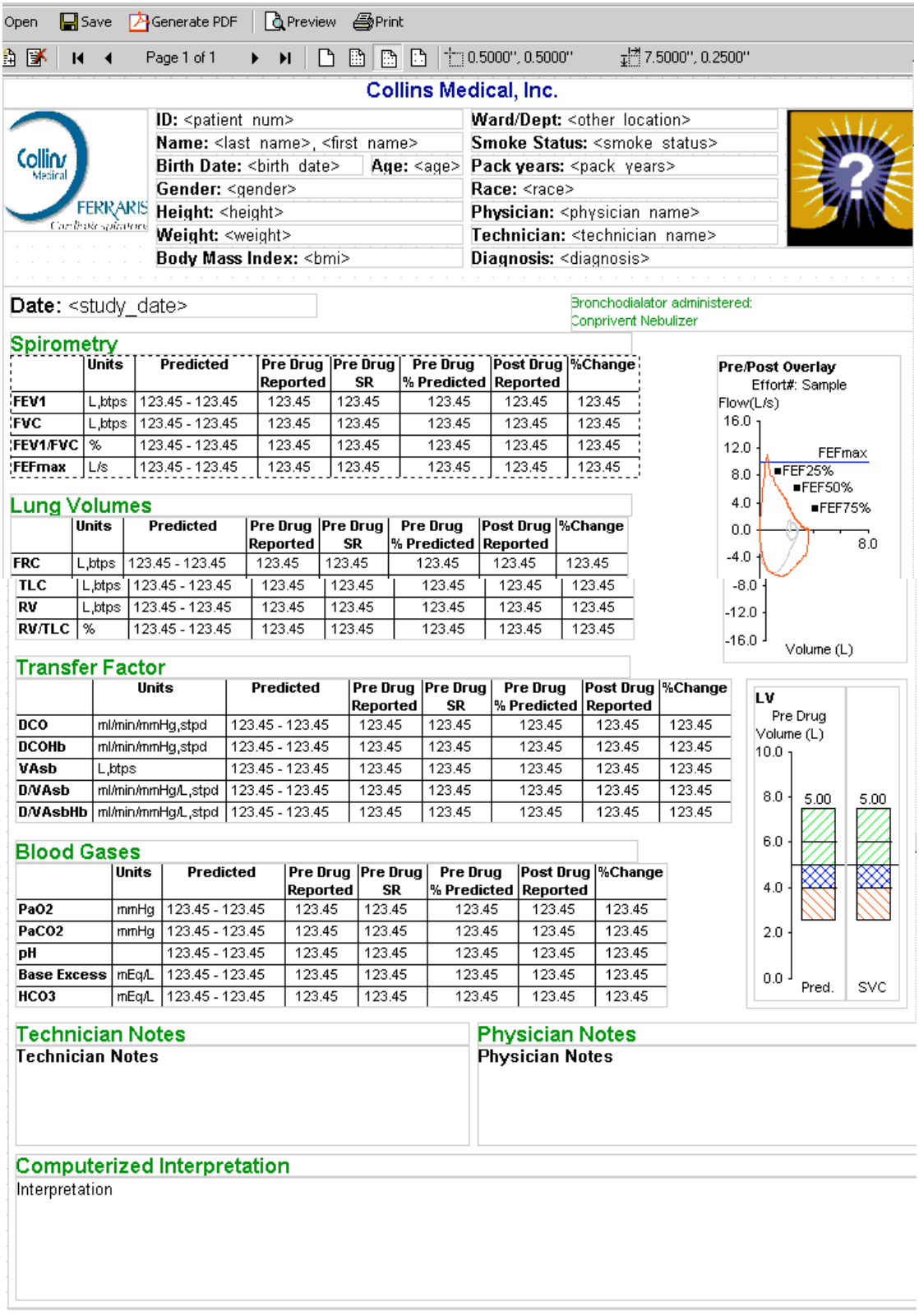


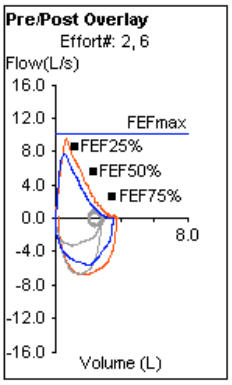

Figure 8-1. A Preconfigured Extended Report in Setup View

Open Save Generate PDF Preview Print

Page 1 of 1 6.3125", 2.7500" 1.5000", 2.5000"

## Spirometry

| | Units | Predicted | Pre Drug Reported | Pre Drug SR | Pre Drug % Predicted | Post Drug Reported | %Change |
|---|---|---|---|---|---|---|---|
| FEV1 | L,btps | 3.82 | 3.15 | -1.31 | 82.53 | 3.22 | 1.99 |
| FVC | L,btps | 4.64 | 3.85 | -1.29 | 83.01 | 4.01 | 4.08 |
| FEV1/FVC | % | 81.09 | 81.96 | 0.12 | 101.07 | 80.31 | -2.01 |
| FEFmax | L/s | 10.07 | 9.32 | -0.62 | 92.57 | 9.58 | 2.73 |

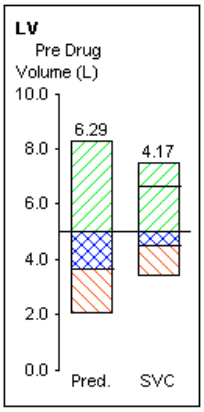



## Lung Volumes

| | Units | Predicted | Pre Drug Reported | Pre Drug SR | Pre Drug % Predicted | Post Drug Reported | %Change |
|---|---|---|---|---|---|---|---|
| FRC | L,btps | 3.02 | 1.67 < | -2.26 | 55.16 < | 2.41 | 44.66 |
| TLC | L,btps | 6.57 | 4.17 < | -3.43 | 63.47 < | 5.52 < | 32.43 |
| RV | L,btps | 1.65 | 1.13 | -1.28 | 68.37 < | 1.57 | 38.40 |
| RV/TLC | % | 27.22 | 27.12 | -0.02 | 99.63 | 28.34 | 4.51 |

## Transfer Factor

| | Units | Predicted | Pre Drug Reported | Pre Drug SR | Pre Drug % Predicted | Post Drug Reported | %Change |
|---|---|---|---|---|---|---|---|
| DCO | ml/min/mmHg,stpd | 36.79 | 29.57 < | -1.71 | 80.39 | 27.78 < | -6.07 |
| DCOHb | ml/min/mmHg,stpd | 36.79 | 29.57 < | -1.71 | 80.39 | 27.72 < | -6.27 |
| VAsb | L,btps | 6.57 | 5.49 | | 83.50 | 5.15 | -6.15 |
| D/VAsb | ml/min/mmHg/L,stpd | 4.76 | 5.67 | 0.22 | 119.12 | 5.46 | -3.71 |
| D/VAsbHb | ml/min/mmHg/L,stpd | 4.76 | 5.67 | 0.22 | 119.12 | 5.46 | -3.71 |




## Blood Gases

| | Units | Predicted | Pre Drug Reported | Pre Drug SR | Pre Drug % Predicted | Post Drug Reported | %Change |
|---|---|---|---|---|---|---|---|
| PaO2 | mmHg | | | | | | |
| PaCO2 | mmHg | | | | | | |
| pH | | | | | | | |
| Base Excess | mEq/L | | | | | | |
| HCO3 | mEq/L | | | | | | |

## Technician Notes

Possible EARLY OBSTRUCTIVE PULMONARY IMPAIRMENT. This is suggested by the reduced FEF25-75 with a normal FVC and FEV1. This finding can be due to a mild degree of a small airway disease and/or the earliest

## Physician Notes

## Computerized Interpretation

Possible EARLY OBSTRUCTIVE PULMONARY IMPAIRMENT. This is suggested by the reduced FEF25-75 with a normal FVC and FEV1. This finding can be due to a mild degree of a small airway disease and/or the earliest stages of emphysema. This may be reversible in nature, therefore, REPEAT TESTING FOLLOWING BRONCHODILATOR ADMINISTRATION IS RECOMMENDED.
Lung volume testing was performed by helium dilution.
The decreased residual volume (RV) and total lung capacity (TLC) indicate the possibility of a MILD DEGREE OF

Figure 8-2. A Portion of the Same Preconfigured Extended Report in Preview Mode

## Creating a New Extended Report

**NOTE:**

In setting up an extended report, if your printer does not support color, it is recommended that you select black for any color options, as colors will be represented by a gray scale that may difficult to read.

1. From the PLUS main screen, click on the Go To button. At the bottom section of the drop-down menu are the options, *Extended Reports*, *Report Designer* (the standard Final Report program) and Physician Review. Select *Extended Reports*.

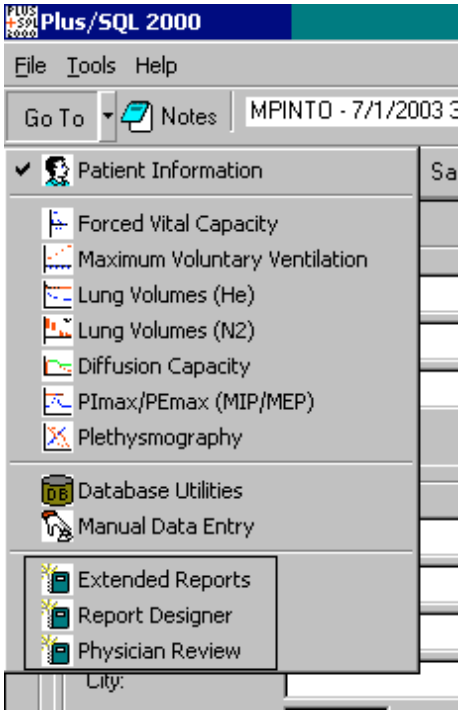



Figure 8-3. The Reports Options on the Go To Menu

2. If this is the first time using the program, a blank report page, toolbox and options will display, as shown in the figure below. If a blank report does not display, click on the *New* button on the File menu bar or click on *New* from the *File* menu at the top of the screen.

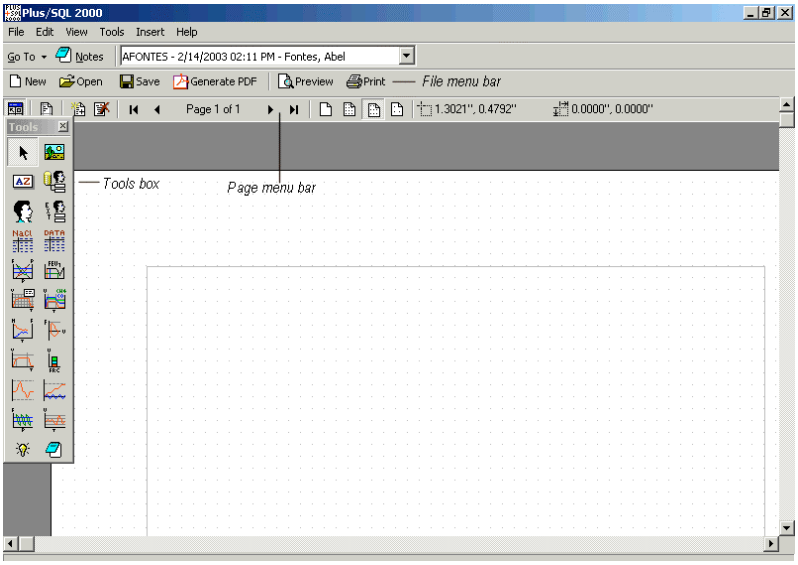



Figure 8-4. The Extended Report Editor

3. The editor has three major control areas:

**The File Menu Bar** – Each report that you create is stored in a file with an .xrd extension. On this menu are options for opening, saving, previewing and printing the current Extended Report file.

Figure 8-5. The File Menu Bar

**The Page Menu Bar** – Contains commands for adding and deleting pages, maneuvering from page to page, creating grids, etc.

Figure 8-6. The Page Menu Bar

**The Toolbox** – Contains a collection of buttons for configuring report sections, such as graphs, demographics, interpretation, etc. Allows you to create and position sections on the page by clicking on the icon, then dragging the mouse to create the outline of the selected section.

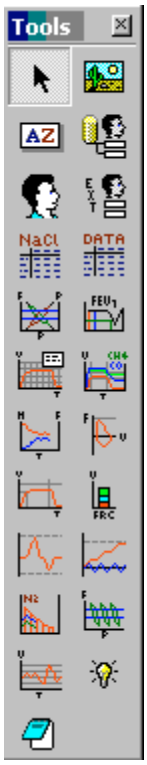



Figure 8-7. The Toolbox

4. Making the desired menu bar active and holding the cursor over a button will display a Tool Tip identifying the function of that button. To make the Tools bar active, place the cursor over the Tools title bar and left-click.

5. Following is a definition of each of the items on the File menu bar, from left to right.

- Allows you to leave the current report to create a new report. If the current report has been modified, you will be asked if you wish to save the changes. Answering *No* will close the current report and any changes will be lost.

- Allows you to open an existing report.

- Allows you to save the current report.

- Allows you to generate the report in PDF format. A licensed copy of the .pdf printer driver software must be purchased separately from Collins Medical, Inc. in order for this function to be available.

- Populates the current report with actual data for the currently selected patient.

- Allows you to print the current report for the current patient.

6. Following is a definition of each of the commands on the Page menu bar, from left to right:

- Click on this icon to display or hide the drop-down Toolbox menu.

- Allows you to Set Up aspects of the current page, such as landscape or portrait, margins, etc. The orientation of each page is handled independently, so a given report can contain pages with a variety of orientations, e.g. portrait and/or landscape.

- Allows you to add a page to the current report.

- Allows you to delete the currently displayed page from the current report.

- Allows you to go to the first page of the report.

- Allows you to go the previous page of the report.

- Shows you the currently displayed page and the number of pages in the report.

- Allows you to display the next page in the report

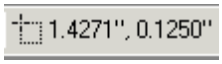
- Allows you to display the last page of the report.

- Allows you to display no grid with which to line up report sections.

- Allows you to display the small-scale grid (1/16”) with which to line up report sections.

- Allows you to display the medium-scale grid (1/8”) with which to line up report sections.

- Allows you to display the large-scale grid (1/4”) with which to line up report sections.



- Shows the cursor’s position on the page.

- Will show the vertical and horizontal dimensions of the section the cursor is pointing to.

7. Following is a definition of each of the commands in the Toolbox, starting from the top.

- Allows you to point to a box on the report to move or resize it.

- Allows you to create a placeholder section for a picture file, such as a company logo, on the current page. Use also to create a shading effect or borders around all sections.

- Allows you to create a text section on the currently displayed page. A full-function RTF (Rich Text File) editor is available for entering and formatting text.

- Allows you to create and position patient information fields on the currently displayed page.

- Allows you to create and position a placeholder section for the patient photo from the Patient Information data.

- Allows you to create a section on the report for displaying user-defined fields.

- Allows you to create a Challenge Testing Data section on the currently displayed page.

- tabular test data.

- disability graph (must always be a full page with landscape orientation.

- DL graph.

- FRC graph.

- FVC flow-volume graph.

- FVC volume-time graph.

- lung volumes bar graph.

- Mip-Mep graph

- MVV graph.

- Nitrogen Washout graph

- Raw graph

- Volume graph

- computerized interpretation

- technician and/or physician notes

8. Toolbox options are also available from the *Insert* menu.

9. You may move and resize the Toolbox. To move it, point to the *Tools* title bar at the top, hold down the left mouse button and drag the Toolbox to the desired position on the screen. To resize, hold the cursor over the right outside edge of the Toolbox until you see the double arrow; then hold down the left mouse button and drag the Toolbox into the desired shape.

10. Keep in mind that most of the options shown on these menu bars are also available from the drop-down menus in the Windows® bar at the top of the screen. The options available depend on the portion of the Extended Reports program you are working in.

Figure 8-8. The Windows® Bar of the PLUS Program

11. You will be formatting the report page by page. You may insert additional pages by clicking on the Add Pages button . To select size, margins and orientation for a particular page, make that page current, click on File from the Windows menu bar and select *Page Setup*. You may select Portrait or Landscape orientation independently for each page of a report.

12. Although each of the tool box options contains myriad features, there is a general formula that is common to all of the tools when using them to set up a section of the report:

    a. click on tool

    b. drag cursor on page to draw section box

    c. position and size section box.

    d. right-click on section box to view formatting options

    e. format section

13. To illustrate this procedure, let's first set up a Picture Box section.

**Setting up the Picture Box Section**

1. The Picture Box tool allows you to insert pictures, such as logos, to the final report and to create a backdrop and border to this and any other section box in the report. It supports images in WMF, EMF, BMP, GIF and JPG file formats. You may also paste images from the clipboard into a picture box.

2. If the Toolbox is not showing, click on the Show Toolbox icon in the Page menu bar:

3. Make the Toolbox active. If it's not active, the Tools heading will be gray. If it is active, it will be blue. Activate or deactivate the toolbox by clicking on the Tools heading.

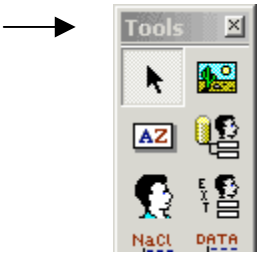



Figure 8-9. Activating the Toolbox

4. Left-click on the Picture Box icon in the Toolbox.

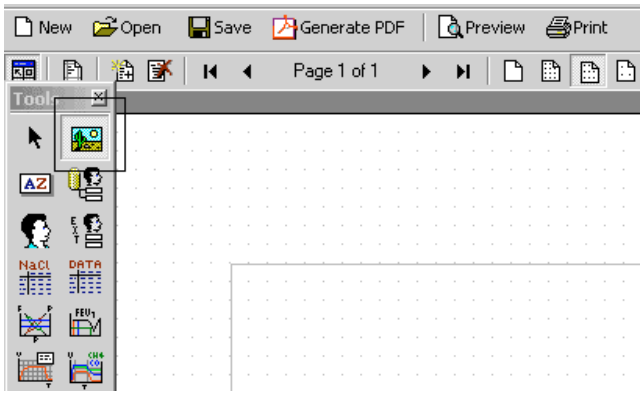



Figure 8-10. Selecting the Picture Box Option in the Toolbox

5. Position your cursor at the approximate point on the page where you want to place the Picture section. Hold down the left mouse button and drag the mouse diagonally to draw the approximate shape of the section. Let go of the left mouse button when you have completed the shape.

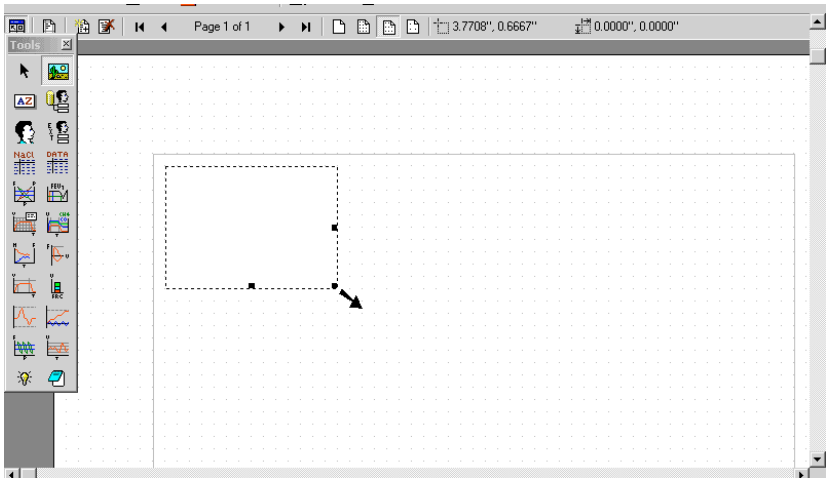



Figure 8-11. Dragging the Cursor to Position and Size the Section

6. Right-click on the section to view the formatting options for that section.

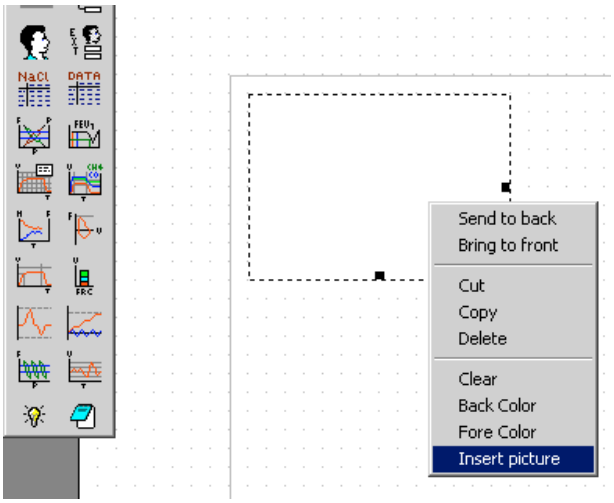



Figure 8-12. Right-Clicking on Section to View Options

7. Select *Insert Picture*.

8. At the picture dialog, select the desired picture file to insert and click Open.

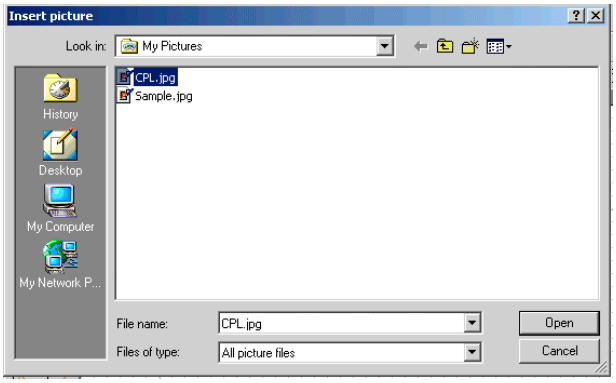



Figure 8-13. Selecting a Picture File to Insert

9. The picture will display in the box.

10. Select the pointer tool to move and resize the picture to the desired dimensions.

11. With the left mouse button, click on the picture to show the sizing handles. To resize the picture, grab the handles that appear at the sides and corner of the picture and drag them until the picture is the desired size.

    Another way to size a section box is to select it, hold down the Shift key and press the desired arrow key.

12. If you have activated one of the grid buttons, the picture will snap to the closest grid line when you release the mouse button (or use Shift plus the desired arrow key). If you find that the picture is being sized in too large or too small increments, change the size of the grid by clicking on one of the other grid buttons.

13. If you don't want a grid, click on the No-Grid button. Pressing Shift and the desired arrow key will size the section one pixel at a time.

14. With a graphic section such as the Picture Box, the Size guide will show you the size of your graphic for as long as you hold the cursor over the section.

15. Hold down the left mouse button at a point inside the picture and drag the picture to the desired position on the page.

    Another way to move a section box is to select it, hold down the Ctrl key and press the desired arrow key.

16. Again, if you have selected a grid, the picture will snap to the nearest grid when you release the mouse button (or use Ctrl plus the desired arrow key). If you are not using a grid, pressing Ctrl and the desired arrow key will move the section one pixel at a time.

17. The Position guide will show you the position of your cursor on the screen. To find the position of the section on the screen, hold the cursor at a section boundary.

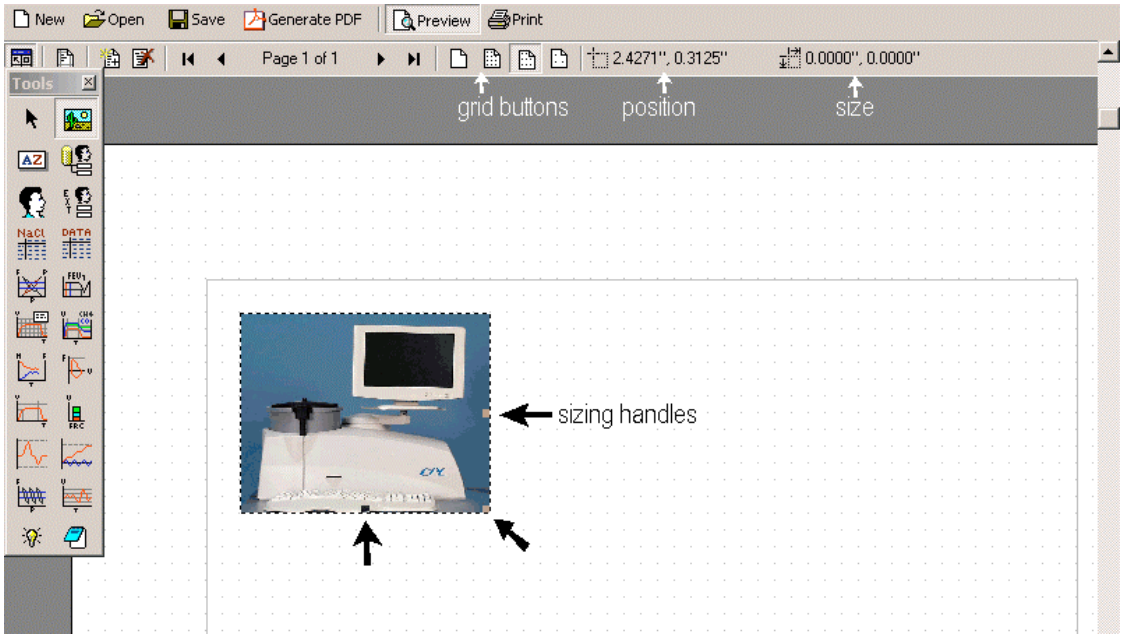



Figure 8-14. Inserting and Formatting the Picture File

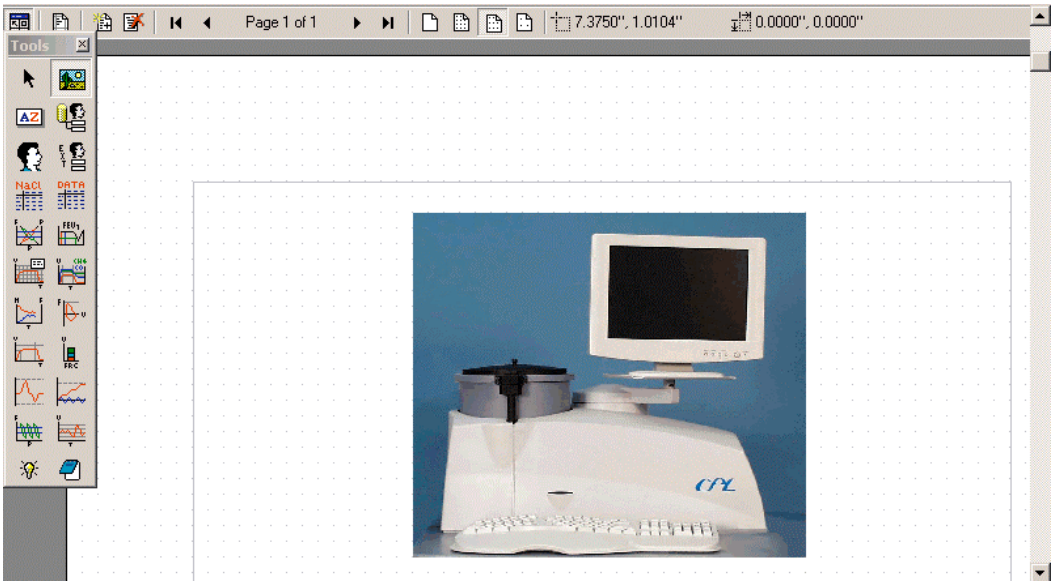



Figure 8-15. The Picture Section Resized and Repositioned

18. To draw a frame for this and other report sections, draw another slightly bigger picture box around the picture. The new box will cover the first one for the time being.

19. The two boxes are actually layered one on top of the other. Right click on the new box and select Send to Back in order to send the new box behind the original box. You will see just the outline of the new box around the first box. Use Send to Back and Bring to Front to move the currently selected box to the front or the back.

20. To change the color of the frame box, left-click inside it to select it. Then right-click and select Background Color. The standard Windows color dialog will display, allowing you to change the color of the box. All you will see is the colored frame around the photo since it's layered underneath the photo.

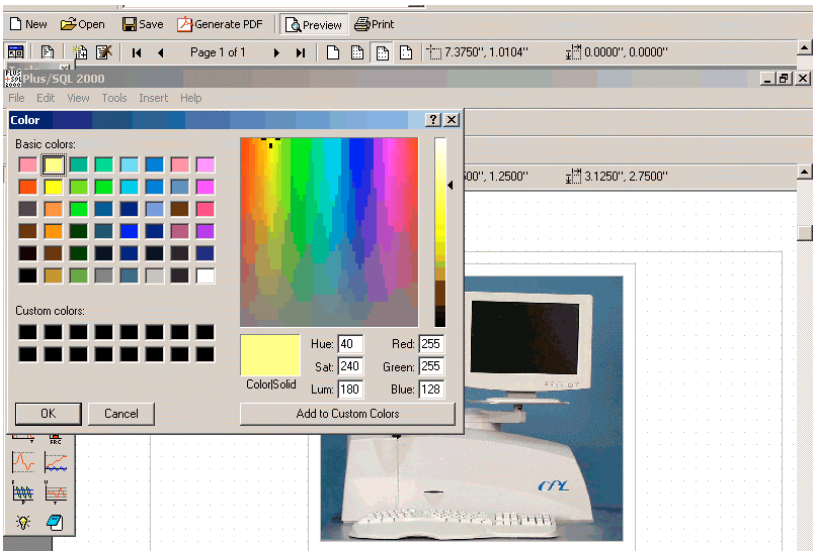



Figure 8-16. Selecting the Background Color

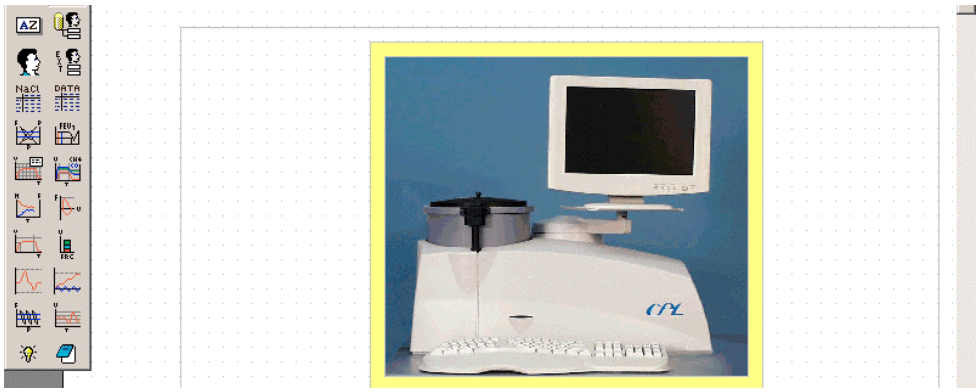


Figure 8-17. Photograph Section with Colored Border

21. The outside border of the frame is black by default. To change the border color, select Foreground Color. From the color dialog, select a color for the border. In our example we have chosen yellow for the frame and red for the border. In order to see the border color, select Preview.

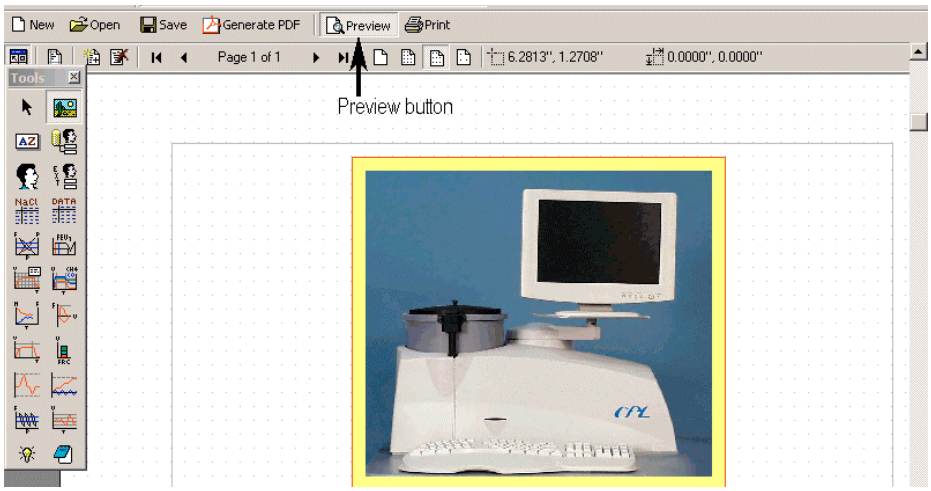



Figure 8-18. Sample Picture Section with Frame and Border

22. To have a frame without a border, change the border color to white.

23. To create a shadow effect, move either one of the boxes to offset it from the other as in the following example.

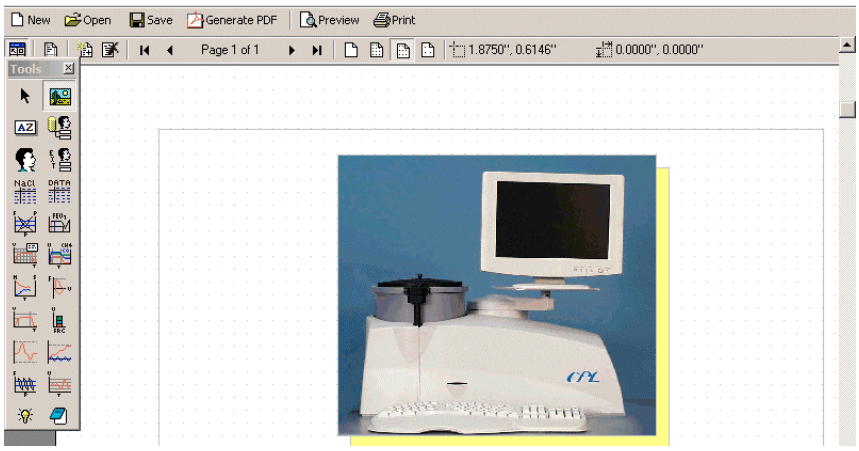



Figure 8-19. Creating Shadow for Picture Box

24. You may also copy and paste a picture section, as shown below.

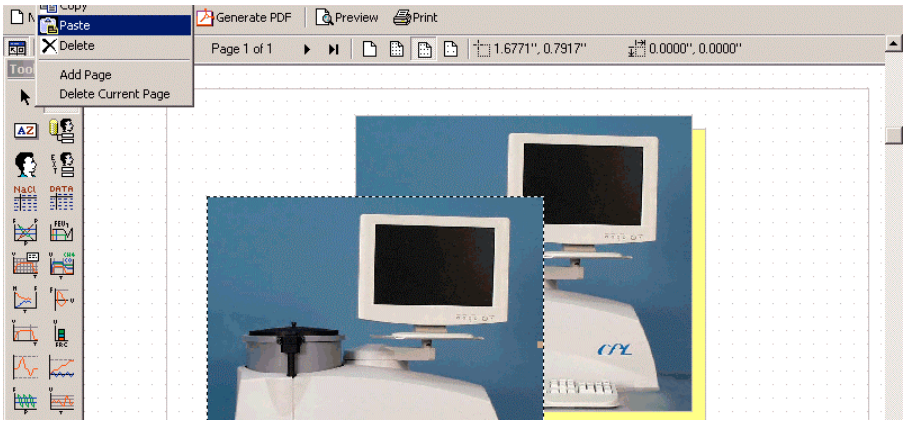



Figure 8-20. Copying and Pasting a Section

25. To remove an unwanted section, select Cut either from the right-click menu or the Edit menu, or click on the box to make it active (indicated by the dashed border) and press the Delete key.

26. You may place items outside the margins; they are there only as guidelines.

**Setting up a Text Section**

1. The text box may be used to set up a report heading or other textual information anywhere in the report. Click on the Text Icon from the Toolbox:

2. Drag the cursor on the page to draw this section box.

3. Right-click on the text box to view the formatting options.

4. Select Edit. The text area formatting dialog will display. Type in and format the desired text. You may also paste text from the clipboard into the Text box.

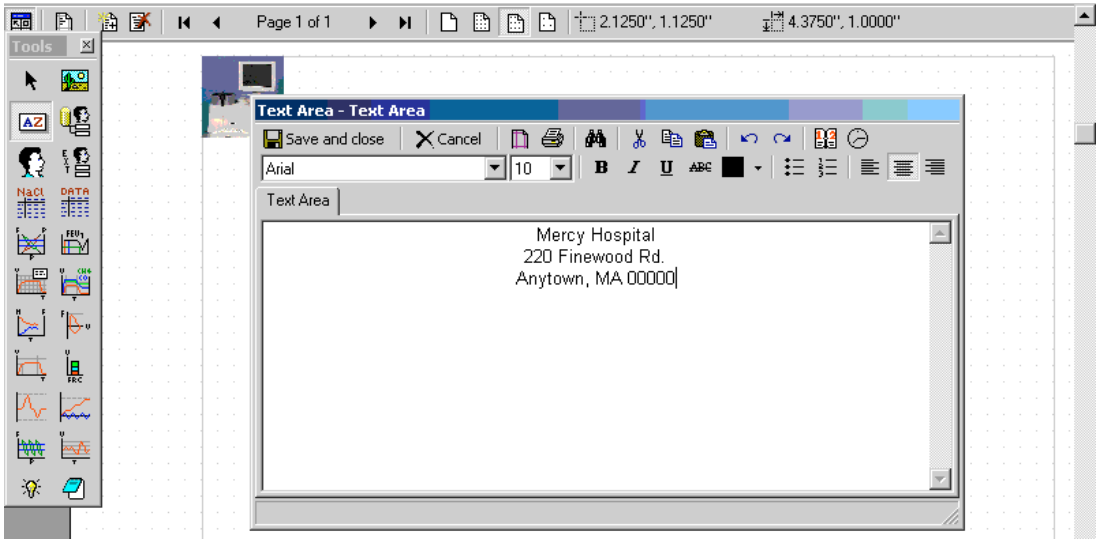



Figure 8-21. Formatting the Text Box

5. When done formatting, select *Save and close*. The formatted text will appear on the report page.

6. Size and position the text box as desired. If there is not sufficient room for the text entered, enlarge the text box.

7. Using the picture box tool, you may add a border to the text area as described under *Setting up the Picture Box Section*. Simply compose a picture box around the text box, then send it to the back. Change the frame and border colors as desired. Following is an example of a text box with frame and border as seen in Preview mode.

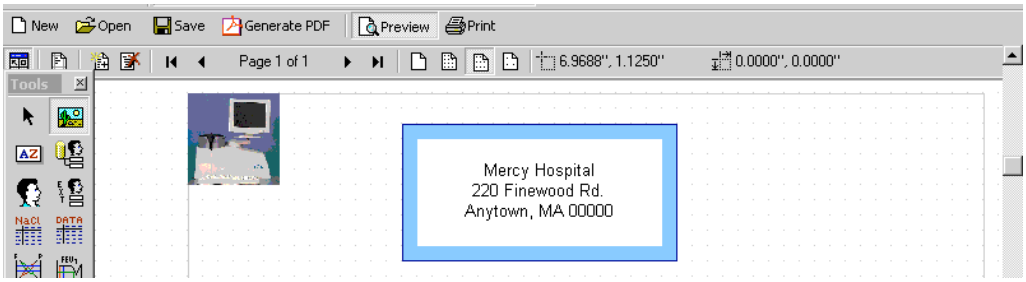



Figure 8-22. Sample Text Box with Frame and Border

**Setting up the Patient Information and Study Data Box**

1. This tool option allows you to place demographic fields anywhere in the report. To select this option, click on the Patient Information and Study Data Box icon in the Toolbox:

2. Drag the cursor on the page to draw the box for the first patient information field. This field and all others will be labeled Patient ID by default.

3. To change the default <Patient ID> label to the desired field label, right-click on the Patient ID field. A pop-up menu will display a list of all available patient information fields, which are the same as the ones in the Patient Information program.

**NOTE:**
The insert menu has two additional options: Body Mass Index (BMI) and Predicted, which inserts the name of the currently selected predicted protocol.

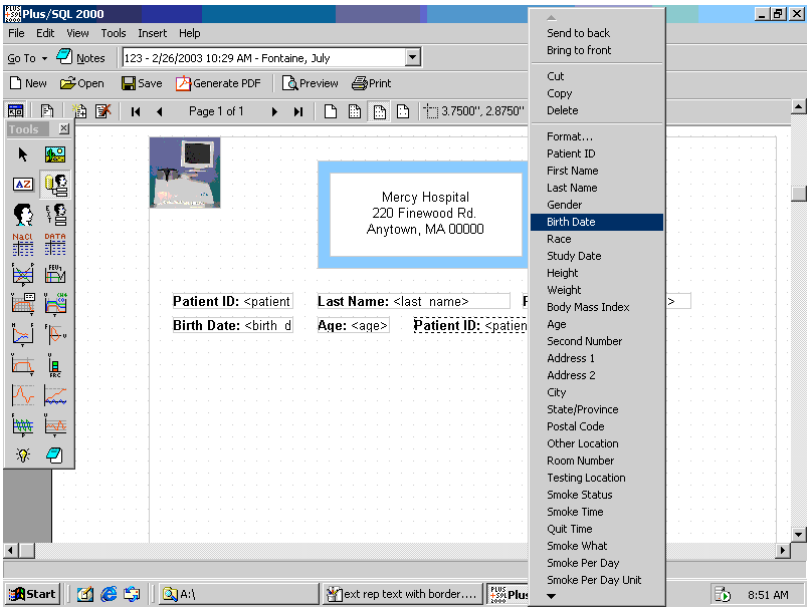



Figure 8-23. The Available Patient Information Fields

4. Select the desired field from the list. The new field e.g., Birth Date, will replace the Patient ID field.

5. To format the field, select it and right-click on it. From the menu, select Format.

6. A Properties dialog will display the field label, e.g. Birth Date, and the Value, or content, of that field, e.g. <birth date>. When you look at the report in Preview mode, the Value will reflect what you have entered for that particular field in the Patient Information program for the current patient. For example, if the birth date for the current patient is 6/16/1954, the program will display this date in the Preview mode.

7. The default Label for a field can be changed. For example, <birth date> can be changed to Date of Birth or DOB by selecting Format from the right-click menu, selecting the desired field (value) and entering the desired label.

8. You may also format the text for the Label and Value. Clicking the button next to either category will display a format dialog as in the following example.

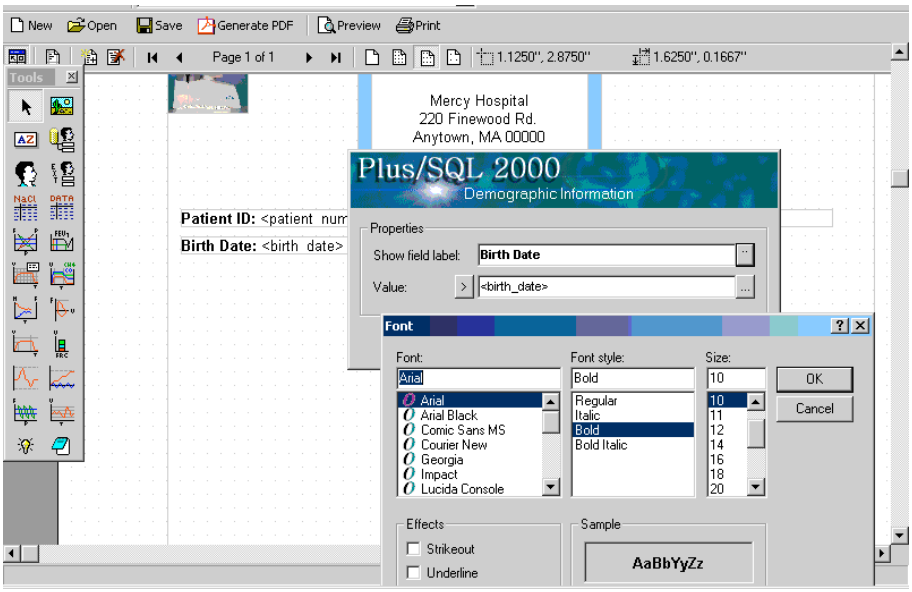



Figure 8-24. Formatting a Patient Information Field

9. For example, if you select *Bold* for the Field Label, Birth Date will be in bold face type. If you select Italic for the Value, the actual date, e.g., 6/16/1954 will appear in italics.

10. You may combine more than one value under a single field label. For example, you may wish to combine the Last Name and First Name fields into a single field. To do so, first create a Last Name field, making it long enough to contain both values.

11. With the Last Name field selected, right-click and select Format from the menu. The properties dialog will display.

12. In the Values box, type a comma next to <last name>, since you would normally see the two values separated by a comma and a space (e.g. Doe, John).

13. Click on the arrow next to *Value*. The Insert menu will display. Select First Name, which will then display next to Last Name in the Values box. The field label can be made to reflect the display format of Last Name, First Name, e.g., *Last Name, First* or *Name (Last, First)*.

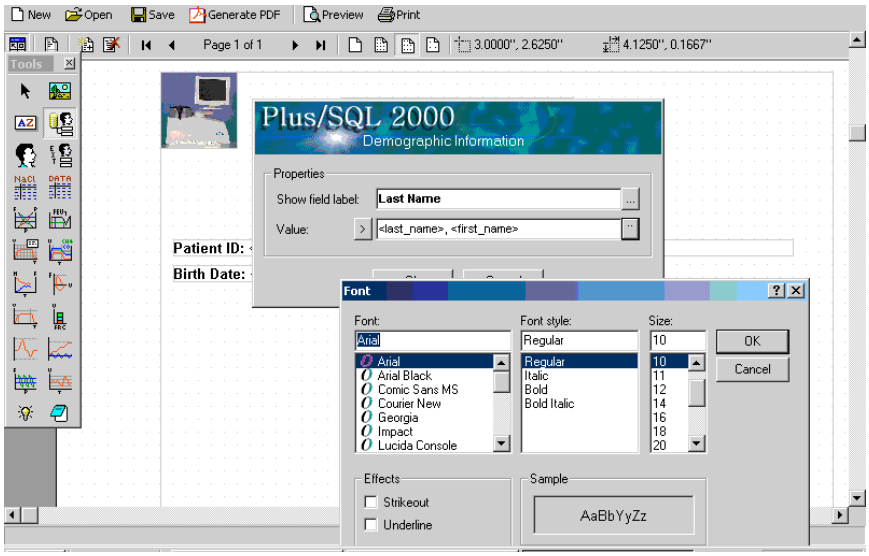



Figure 8-25. Combining Values under a Field Label

14. An efficient way to set up a number of fields quickly is to first draw a series of Patient ID fields. Then right-click on each one to replace them with the fields of your choice and then format them as desired.

15. To move a field to any place on the page, simply place the cursor over it and drag to the desired location. This allows you a great deal of flexibility in arranging the fields.

16. Refer to the figure below to see a sample of some fields filled with actual information in the Preview mode.

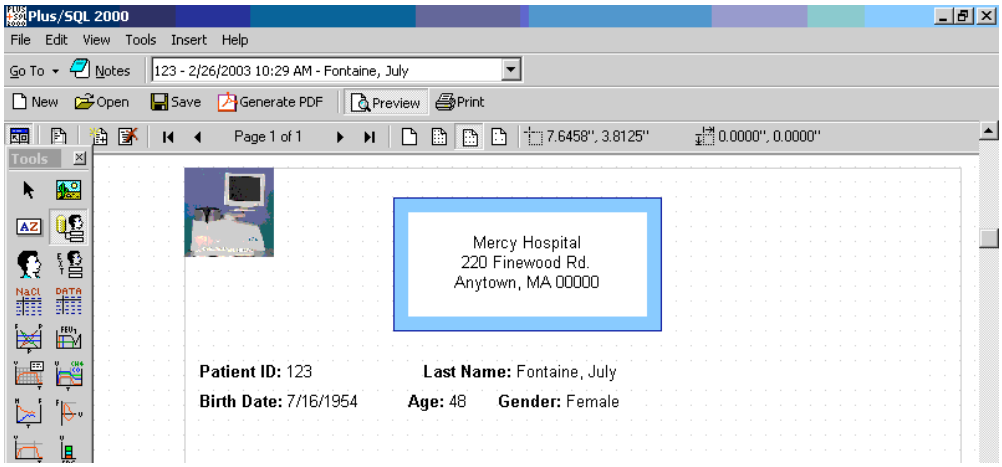



Figure 8-26. Patient Information Fields in Preview Mode

**The Patient Photo Section**

1. The patient photograph referred to here is the picture file created with a digital imaging camera and displayed in the Patient Photo field on the Patient Information screen.

2. Set up the Patient Photo box in the desired location by dragging and dropping as described for the previous options. The program will display the Patient Photo icon.

3. When you click on Preview, the program will display the actual photo of the current patient, if Patient Information includes a photo.

4. Move and size the photo, as desired. You may create a border around it by using the picture box option in the Toolbox. If colors other than white are selected, then the border is drawn even if there is no photo available for the patient.

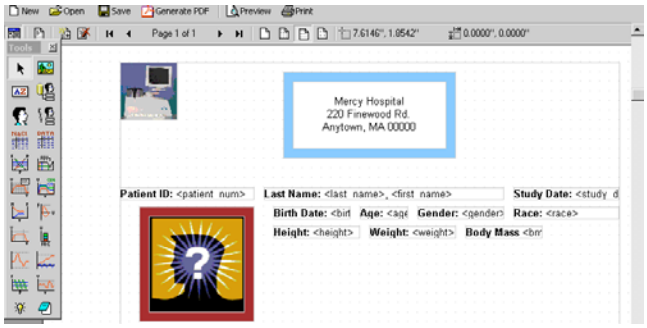



Figure 8-27. Patient Photo Box Setup

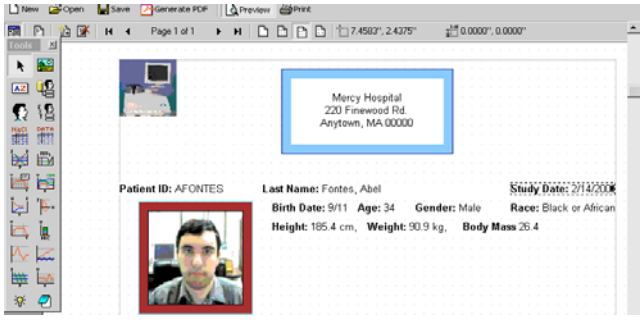



Figure 8-28. Patient Photo Box in Preview Mode

**User Defined Fields Section**

1. To insert the User Defined Fields as a block from the Patient Information program, click on this icon:

2. Format, size and position the User Defined Fields section as described for the Text Box.

**Tabular Data Section**

1. To insert a Tabular Data box, click on this icon:

2. Drag to create the tabular data box. The box will size itself to fit the available fields. If more fields are selected than will fill on the page, the box will extend off the page and some fields will not be visible.

3. Right-click on the graph to view the setup options.

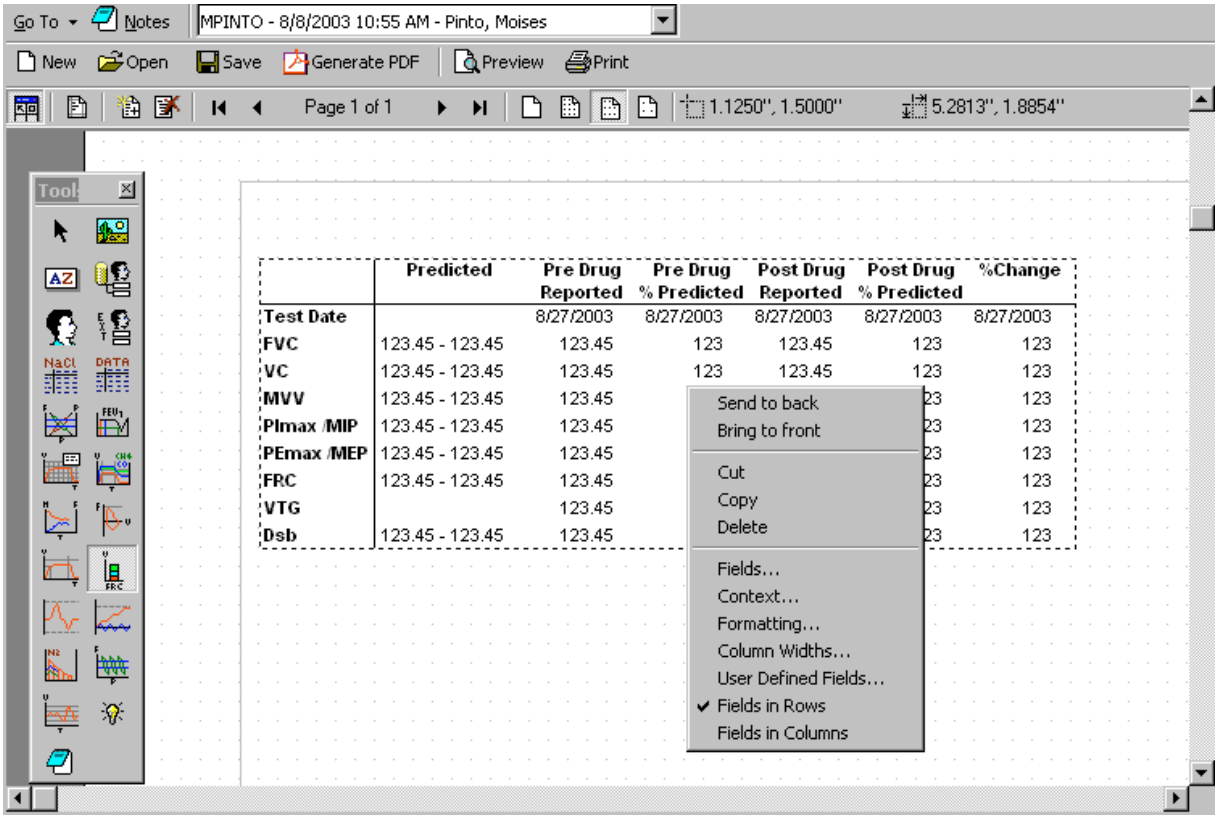



Figure 8-29. Right-click Options for the Tabular Data Section

4. As an example, to create a tabular box for Forced Vital Capacity data, from the right-click menu, select *Fields*.

5. The Tabular Data Fields dialog will display, as shown in the figure below. Click on the down arrow at the right of the Test Type text box to display the drop-down menu of Test Types. Select *Forced Vital Capacity*.

6. From the available fields list, click on a field to select it, then click on the right arrow button to move it to the Selected Fields window. To move all of the available fields, click the double arrow button . Delete any undesired field from the Selected Fields box by highlighting it and clicking on the Delete button . To delete all the fields from the Selected Fields box, click on the multiple fields delete button . To reposition a field in the list, highlight it and use the up and down arrow buttons to move it to the desired position.

7. An alternate way to select fields is to send all the available fields to the Selected Fields window using the double arrow key. Then click the Delete button for each undesired field.

**NOTE:**

The Available Fields list allows you to report up to eight Pre-Drug and eight Post-drug tests. Keep in mind that the effort numbers in Available Fields do not necessarily correspond to the effort numbers from the actual test, since you may have deleted one or more efforts while in the test module. However, in the actual report, the effort numbers from the actual test will be displayed.

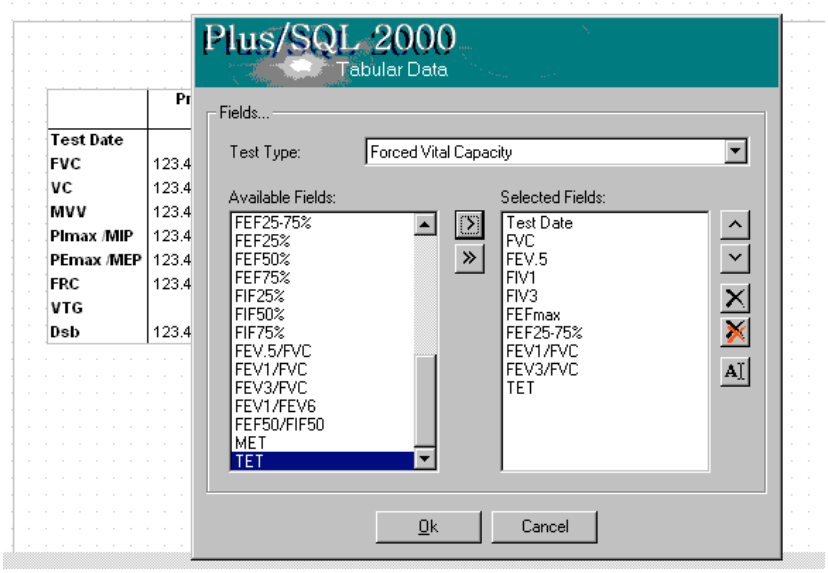



Figure 8-30. Selecting Tabular Data Fields

8. To modify the name of a field, highlight it in the Selected Fields box and click on the Edit button . The program will display a pop-up dialog that allows you to edit the name of the field.

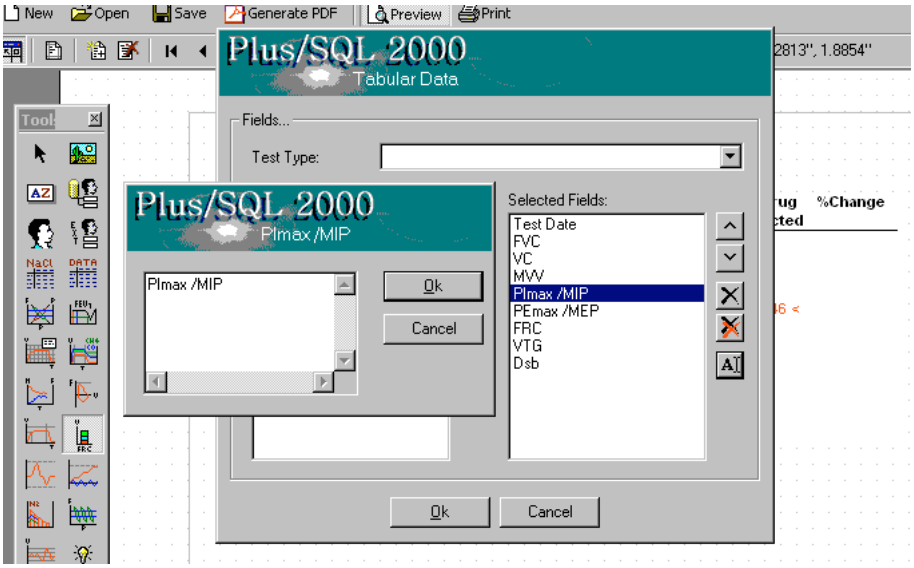



Figure 8-31. Editing Fields in the Tabular Data Section

9. To enter a new line for the field name, press the *Ctrl* and *Enter* keys simultaneously at the cursor.

10. Click OK when done editing the field name.

11. When satisfied with all selected fields, click OK.

12. With the cursor positioned over the Tabular Data section, right-click to display the context menu. Select *Context Headings*.

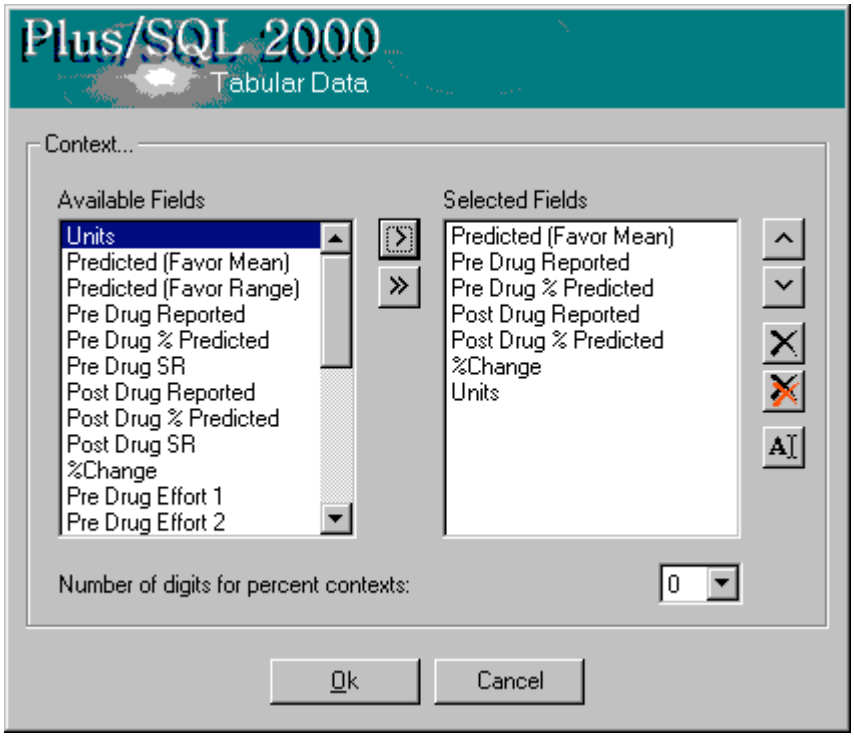



Figure 8-32. Selecting Tabular Data Context Headings

13. In the Context dialog, use the same procedure to select and edit Context headings as you did for Fields. To modify a Context Heading, highlight it in the Selected Fields box and click on the Edit button . The program will display a pop-up dialog that allows you to edit the context name.

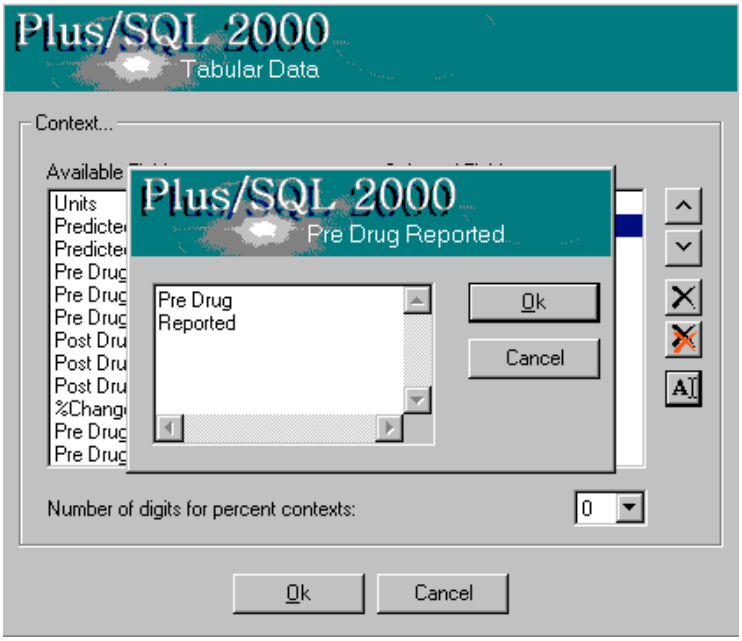



Figure 8-33. Editing Context Headings in Tabular Data

14. To enter a new line for the context name, press the *Ctrl* and *Enter* keys simultaneously at the cursor.

15. To change the number of digits displayed following the decimal in percentage context headings (such as %Predicted), click on the down arrow and select the desired number. Zero will give you no decimal places, as in 14%, one will give you one decimal place, as in 14.3%, etc.

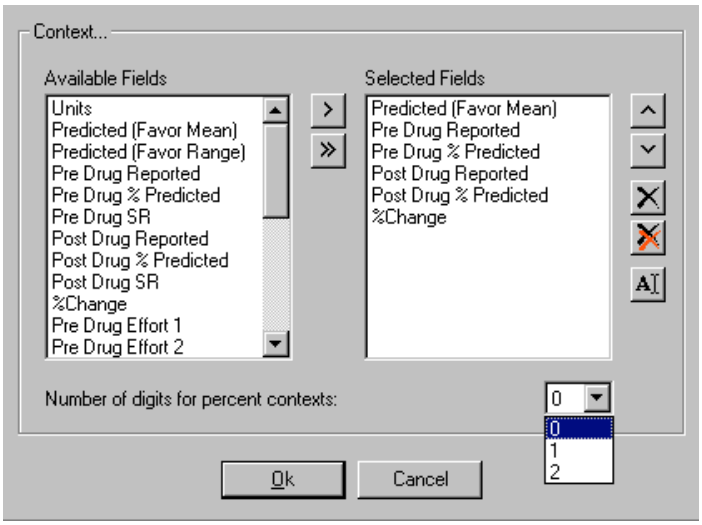



Figure 8-34. Editing Digits for Percent Contexts in Tabular Data

16. When done configuring context headings, click OK.

**NOTE:**

The context headings *Pre-drug SR* and *Post-drug SR* refer to Standardized Residuals. These values will be calculated only if the current predicted protocol set includes the standard deviations needed to calculate Standardized Residuals.

17. The Fields and Context headings you selected will be displayed in the tabular box, from left to right in the order listed.

| | Units | Predicted | Pre Drug Reported | Pre Drug % Predicted | Post Drug Reported | Post Drug % Predicted | %Change |
|---|---|---|---|---|---|---|---|
| **Test Date** | | | 2/14/2003 | | 2/14/2003 | | |
| **FVC** | L,btps | 4.64 | 3.85 | 83.01 | 4.01 | 86.39 | 4.08 |
| **FEV.5** | L,btps | | 2.59 | | 2.63 | | 1.69 |
| **FEV1** | L,btps | 3.82 | 3.15 | 82.53 | 3.22 | 84.18 | 1.99 |
| **FEV3** | L,btps | | 3.64 | | 3.77 | | 3.56 |
| **FEFmax** | L/s | 10.07 | 9.32 | 92.57 | 9.58 | 95.09 | 2.73 |
| **FEF25-75%** | L/s | 4.83 | 3.29 | 68.04 < | 3.18 | 65.76 < | -3.35 |
| **FEV1/FVC** | % | 81.09 | 81.96 | 101.07 | 80.31 | 99.03 | -2.01 |
| **FEV3/FVC** | % | | 94.49 | | 94.02 | | -0.50 |
| **TET** | s | | 7.73 | | 8.37 | | 8.25 |

Figure 8-35. The Selected Columns and Fields in Preview Mode

18. If you have some programming knowledge and wish to create a field that is not shown in the Available Fields box, select User Defined Fields from the right-click menu. The following dialog will display.

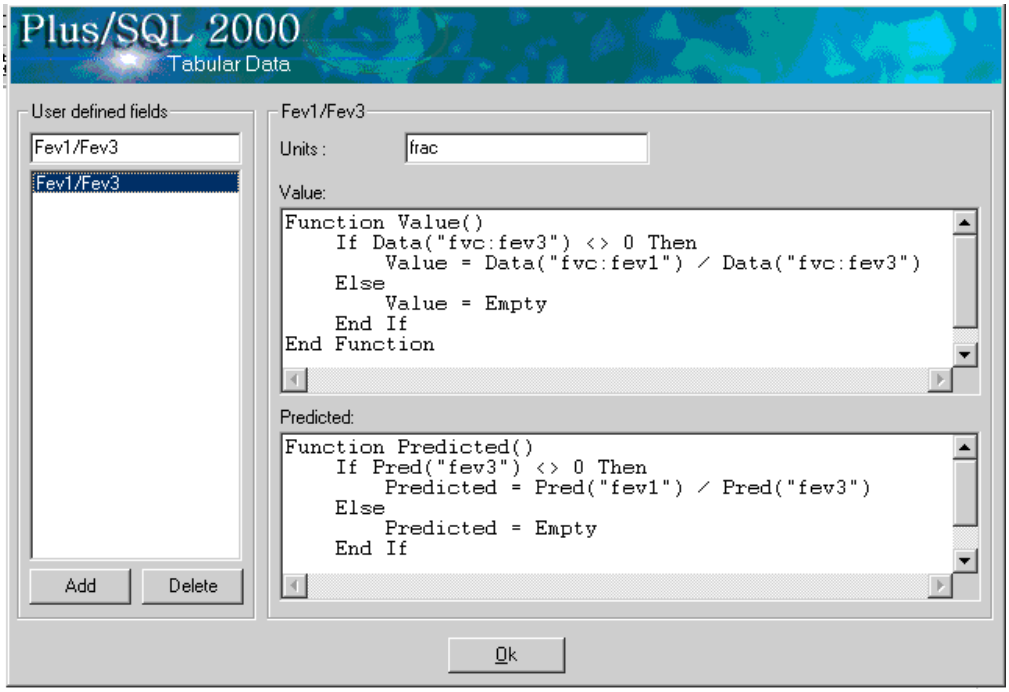



Figure 8-36. The User-Defined Field Dialog

19. The above example shows the function for the user-defined field, Fev1/Fev3. First click on Add to create a field. Then enter Fev1/Fev3. Enter the units for this parameter in the *Units* text box; in this case we have used frac for fraction. Then specify the value for this parameter. Note that fvc refers to the test type and fev1 and fev3 refer to the parameters from this test type. Enter the Predicted equation for this parameter if desired.

20. Add as many user-defined fields as desired. When done, click on OK.

21. To enter the new User-Defined fields into the Forced Vital Capacity list, select Fields from the right-click menu. For the Test Type, select User-Defined Fields. All User-Defined fields will display in the Available Fields list. Move the desired User-Defined field(s) (in our example, FEV1/FEV3) to the Selected Fields list.

**NOTE:**

The creation of a User-Defined function requires knowledge of the Microsoft Visual Basic Scripting language and the Collins PLUS/sql database field names for available parameters. This is an advanced feature of Extended Reports and is beyond the scope of this manual. Please contact Collins Customer Support if you have special needs that might benefit from the advanced power of this feature.

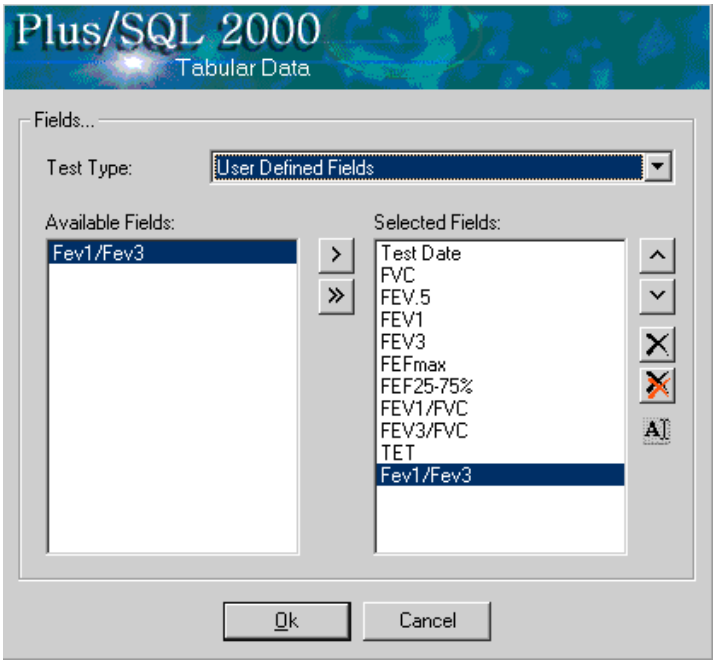



Figure 8-37. Selecting a User-defined Field

22. Now when you look at the Tabular section, the user-defined field will display.

23. If you want to reverse the table position for columns and fields, select Fields in Columns. Note that if you have too many fields, this will exceed the width of the page, so you may have to set up the page in Landscape orientation.

| | Test Date | FVC | FEV.5 | FEV1 | FEV3 | FEFmax | FEF |
|---|---|---|---|---|---|---|---|
| **Units** | | L,btps | L,btps | L,btps | L,btps | L/s | L/s |
| **Predicted** | | 4.64 | | 3.82 | | 10.07 | |
| **Pre Drug Reported** | 2/14/2003 | 3.85 | 2.59 | 3.15 | 3.64 | 9.32 | |
| **Pre Drug % Predicted** | | 83.01 | | 82.53 | | 92.57 | |
| **Post Drug Reported** | 2/14/2003 | 4.01 | 2.63 | 3.22 | 3.77 | 9.58 | |
| **Post Drug % Predicted** | | 86.39 | | 84.18 | | 95.09 | |
| **%Change** | | 4.08 | 1.69 | 1.99 | 3.56 | 2.73 | |

Figure 8-38. Fields in Columns Display

24. To return to the original format, click on Fields in Rows.

25. To configure the width of each column, click on *Column Width*.

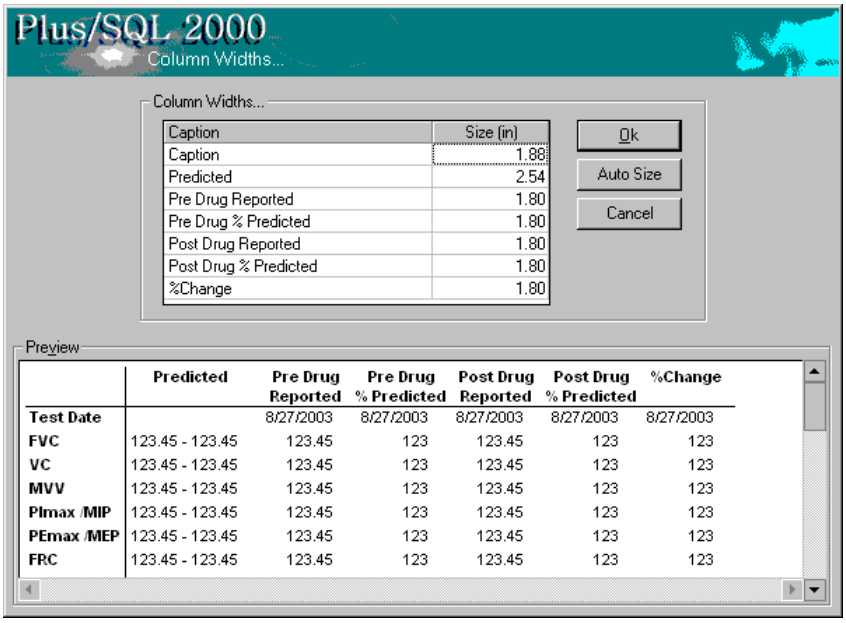

Plus/SQL 2000
Column Widths...
Column Widths...
Caption
Size (in)
Caption 1.88
Predicted 2.54
Pre Drug Reported 1.80
Pre Drug % Predicted 1.80
Post Drug Reported 1.80
Post Drug % Predicted 1.80
%Change 1.80
Ok
Auto Size
Cancel
Preview
Predicted
Pre Drug Reported
Pre Drug % Predicted
Post Drug Reported
Post Drug % Predicted
%Change
Test Date 8/27/2003 8/27/2003 8/27/2003 8/27/2003 8/27/2003
FVC 123.45 - 123.45 123.45 123 123.45 123 123
VC 123.45 - 123.45 123.45 123 123.45 123 123
MVV 123.45 - 123.45 123.45 123 123.45 123 123
PImax /MIP 123.45 - 123.45 123.45 123 123.45 123 123
PEmax /MEP 123.45 - 123.45 123.45 123 123.45 123 123
FRC 123.45 - 123.45 123.45 123 123.45 123 123

Figure 8-39. The Tabular Data Column Width Dialog

26. The resulting dialog will display the existing column widths in inches or centimeters, depending on which unit has been selected in the Windows *Regional Settings* (click on the *Start Button, Settings, Control Pad, Regional Settings*). To change the width for an individual column, click on the corresponding Size box, type in the new value, and press Enter.

27. If you have activated the Preview button

in the report setup window, you will be able to see a preview of the new column widths in the lower part of the dialog using the currently selected patient's data.

28. To have every column automatically sized to accommodate the width of the largest value therein, click on the *Auto Size* button. If you are in preview mode, you will be able to see what the columns look like in the lower part of the dialog.

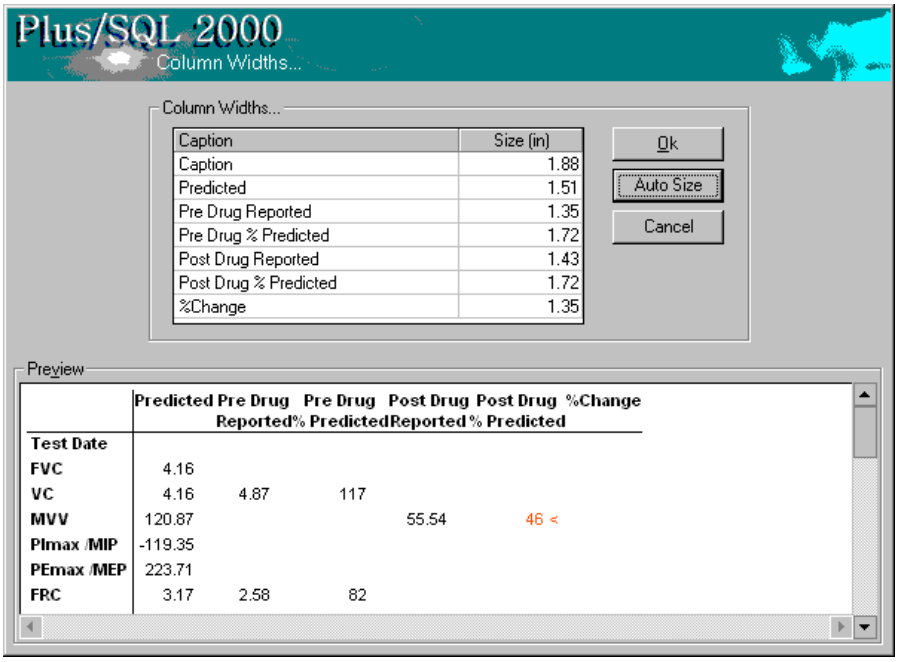



Figure 8-40. Sample Auto-Sized Columns in Tabular Data

29. When done changing column widths, click OK.

30. To format font and color aspects of the tabular box, click on *formatting* from the right-click menu. The formatting dialog will display:

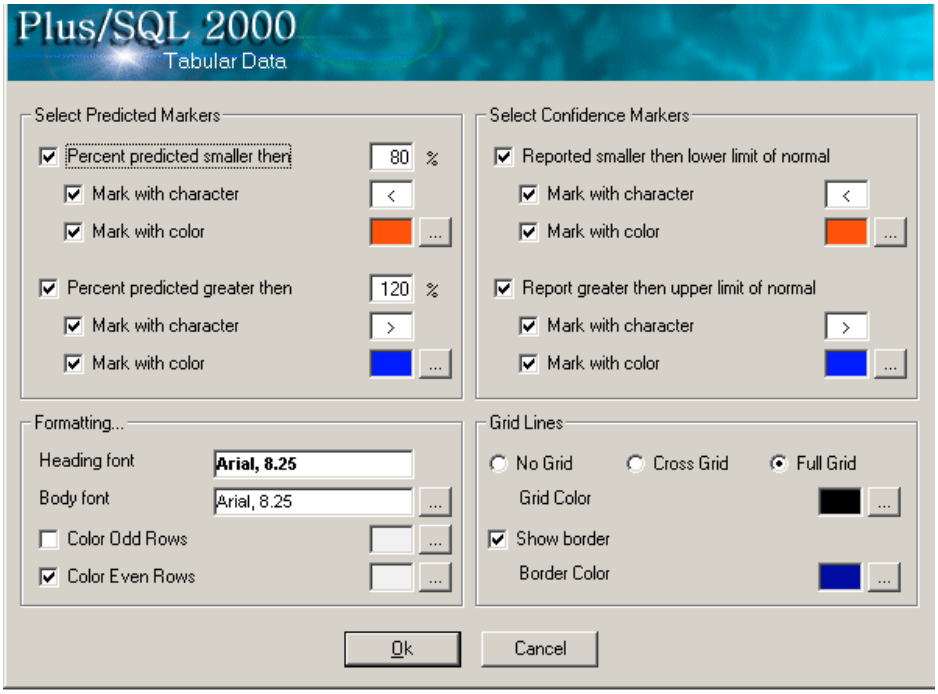



Figure 8-41. The Formatting Dialog

31. To flag values on the report that are less than or greater than a specified percentage of predicted, check *Percent Predicted Less than* or *Percent Predicted Greater than*. Then enter in the limit in the boxes across from these fields. If you want the flag to be represented by a character and/or color, check these boxes. Do the same for the upper and lower limits of normal. Uncheck the appropriate boxes if you do not want to flag particular values.

32. To change the heading and body fonts and styles, click on the button next to these features. A standard font dialog will display.

33. If you want alternate rows in the table to be colored for better viewing, check off whether you want the odd or the even rows colored. If you want both colored, check off both. Select the desired color for whichever option you select by clicking on the color button across from it. A standard color dialog will display. Uncheck the appropriate option if you want uncolored rows.

34. If you don't want grid lines on the table, select No Grid. If you want grid lines to separate just the row and column headings from the rest of the table, select Cross Grid. If you want the table to have a spread-sheet effect, select Full Grid.

| | Units | Predicted | Pre Drug Reported | Pre Drug % Predicted | Post Drug Reported | Post Drug % Predicted | %Change |
|---|---|---|---|---|---|---|---|
| **Test Date** | | | 2/14/2003 | | 2/14/2003 | | |
| **FVC** | L,btps | 4.64 | 3.85 | 83.01 | 4.01 | 86.39 | 4.08 |
| **FEV.5** | L,btps | | 2.59 | | 2.63 | | 1.69 |
| **FEV1** | L,btps | 3.82 | 3.15 | 82.53 | 3.22 | 84.18 | 1.99 |
| **FEV3** | L,btps | | 3.64 | | 3.77 | | 3.56 |
| **FEFmax** | L/s | 10.07 | 9.32 | 92.57 | 9.58 | 95.09 | 2.73 |
| **FEF25-75%** | L/s | 4.83 | 3.29 | 68.04 < | 3.18 | 65.76 < | -3.35 |
| **FEV1/FVC** | % | 81.09 | 81.96 | 101.07 | 80.31 | 99.03 | -2.01 |
| **FEV3/FVC** | % | | 94.49 | | 94.02 | | -0.50 |
| **TET** | s | | 7.73 | | 8.37 | | 8.25 |
| **Fev1/Fev3** | frac | | 0.87 | | 0.85 | | -1.52 |

Figure 8-42. Tabular Data Section with No Grid

| | Units | Predicted | Pre Drug Reported | Pre Drug % Predicted | Post Drug Reported | Post Drug % Predicted | %Change |
|---|---|---|---|---|---|---|---|
| **Test Date** | | | 2/14/2003 | | 2/14/2003 | | |
| **FVC** | L,btps | 4.64 | 3.85 | 83.01 | 4.01 | 86.39 | 4.08 |
| **FEV.5** | L,btps | | 2.59 | | 2.63 | | 1.69 |
| **FEV1** | L,btps | 3.82 | 3.15 | 82.53 | 3.22 | 84.18 | 1.99 |
| **FEV3** | L,btps | | 3.64 | | 3.77 | | 3.56 |
| **FEFmax** | L/s | 10.07 | 9.32 | 92.57 | 9.58 | 95.09 | 2.73 |
| **FEF25-75%** | L/s | 4.83 | 3.29 | 68.04 < | 3.18 | 65.76 < | -3.35 |
| **FEV1/FVC** | % | 81.09 | 81.96 | 101.07 | 80.31 | 99.03 | -2.01 |
| **FEV3/FVC** | % | | 94.49 | | 94.02 | | -0.50 |
| **TET** | s | | 7.73 | | 8.37 | | 8.25 |

Figure 8-43. Tabular Data Section with Cross Grid

| | Units | Predicted | Pre Drug Reported | Pre Drug % Predicted | Post Drug Reported | Post Drug % Predicted | %Change |
|---|---|---|---|---|---|---|---|
| **Test Date** | | | 2/14/2003 | | 2/14/2003 | | |
| **FVC** | L,btps | 4.64 | 3.85 | 83.01 | 4.01 | 86.39 | 4.08 |
| **FEV.5** | L,btps | | 2.59 | | 2.63 | | 1.69 |
| **FEV1** | L,btps | 3.82 | 3.15 | 82.53 | 3.22 | 84.18 | 1.99 |
| **FEV3** | L,btps | | 3.64 | | 3.77 | | 3.56 |
| **FEFmax** | L/s | 10.07 | 9.32 | 92.57 | 9.58 | 95.09 | 2.73 |
| **FEF25-75%** | L/s | 4.83 | 3.29 | 68.04 < | 3.18 | 65.76 < | -3.35 |
| **FEV1/FVC** | % | 81.09 | 81.96 | 101.07 | 80.31 | 99.03 | -2.01 |
| **FEV3/FVC** | % | | 94.49 | | 94.02 | | -0.50 |
| **TET** | s | | 7.73 | | 8.37 | | 8.25 |
| **Fev1/Fev3** | frac | | 0.87 | | 0.85 | | -1.52 |

Figure 8-44. Tabular Data Section with Full Grid

35. To change the color of the grid lines, click on the color button across from Grid Color.

36. If you want a border around the table, check Show Border. To change the color of the border, click on the corresponding color button.

    In addition to the border mentioned here, you may create a frame around the table or a shadow by using the picture box options.

37. To add a heading to the Tabular section, such as Forced Vital Capacity, draw and format a text section containing the desired label, and position as desired.

38. Shown below is an example of a formatted text section in Preview Mode:

**Forced Vital Capacity**

| | Units | Predicted | Pre Drug Reported | Pre Drug % Predicted | Post Drug Reported | Post Drug % Predicted | %Change |
|---|---|---|---|---|---|---|---|
| **Test Date** | | | 2/14/2003 | | 2/14/2003 | | |
| **FVC** | L,btps | 4.64 | 3.85 | 83.01 | 4.01 | 86.39 | 4.08 |
| **FEV.5** | L,btps | | 2.59 | | 2.63 | | 1.69 |
| **FEV1** | L,btps | 3.82 | 3.15 | 82.53 | 3.22 | 84.18 | 1.99 |
| **FEV3** | L,btps | | 3.64 | | 3.77 | | 3.56 |
| **FEFmax** | L/s | 10.07 | 9.32 | 92.57 | 9.58 | 95.09 | 2.73 |
| **FEF25-75%** | L/s | 4.83 | 3.29 | 68.04 < | 3.18 | 65.76 < | -3.35 |
| **FEV1/FVC** | % | 81.09 | 81.96 | 101.07 | 80.31 | 99.03 | -2.01 |
| **FEV3/FVC** | % | | 94.49 | | 94.02 | | -0.50 |
| **TET** | s | | 7.73 | | 8.37 | | 8.25 |
| **Fev1/Fev3** | frac | | 0.87 | | 0.85 | | -1.52 |

Figure 8-45. Sample Formatted Tabular Data Section

39. The table includes the following selected features:

- The selected fields, including the User-Defined field created, FEV1/FEV3.
- The selected Context headings, including Units.
- Both color and symbol markers for a value under the designated predicted.
- A Full Grid table, which has the look of a spreadsheet.
- Odd-numbered rows highlighted with a selected color.
- The addition of the text heading, Forced Vital Capacity.
- A border around the table.

### Challenge Data Section

1. Select the Challenge Data icon

from the Toolbox and drag the cursor on the page to draw the Challenge section box.

2. Right-click on the Challenge box to view the options menu.

| | Dosage | Breaths | Cumulative Dosage | FVC | FVC %BL | FEV1 | FEV1 %BL | FEF25-75% | FEF2575 %BL | FEFmax | FEFMax %BL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pre Drug** | 123.450 | 123 | 123.4567 | 123.45 | | 123.45 | | 123.45 | | 123.45 | |
| **Baseline** | 123.450 | 123 | 123.4567 | 123.45 | 100 | 123.45 | 100 | 123.45 | 100 | 123.45 | 100 |
| **Set 2** | 123.450 | 123 | 123.4567 | 123.45 | 100 | 123.45 | 100 | 123.45 | 100 | 123.45 | 100 |
| **Set 3** | 123.450 | 123 | 123.4567 | 123.45 | 100 | 123.45 | 100 | 123.45 | 100 | 123.45 | 100 |
| **Set 4** | 123.450 | 123 | 123.4567 | 123.45 | | | 100 | 123.45 | 100 | 123.45 | 100 |
| **Set 5** | 123.450 | 123 | 123.4567 | 123.45 | | | 100 | 123.45 | 100 | 123.45 | 100 |
| **Set 6** | 123.450 | 123 | 123.4567 | 123.45 | | | 100 | 123.45 | 100 | 123.45 | 100 |
| **Set 7** | 123.450 | 123 | 123.4567 | 123.45 | | | 100 | 123.45 | 100 | 123.45 | 100 |
| **Set 8** | 123.450 | 123 | 123.4567 | 123.45 | | | 100 | 123.45 | 100 | 123.45 | 100 |
| **Set 9** | 123.450 | 123 | 123.4567 | 123.45 | | | 100 | 123.45 | 100 | 123.45 | 100 |

Send to back
Bring to front
Cut
Copy
Delete
Formatting...
Fields...

Figure 8-46. Menu Options for Challenge Data Section

3. From the right-click menu, select *Fields*.

4. Select and order the desired fields from the Available Fields list as described for the Tabular Data section.

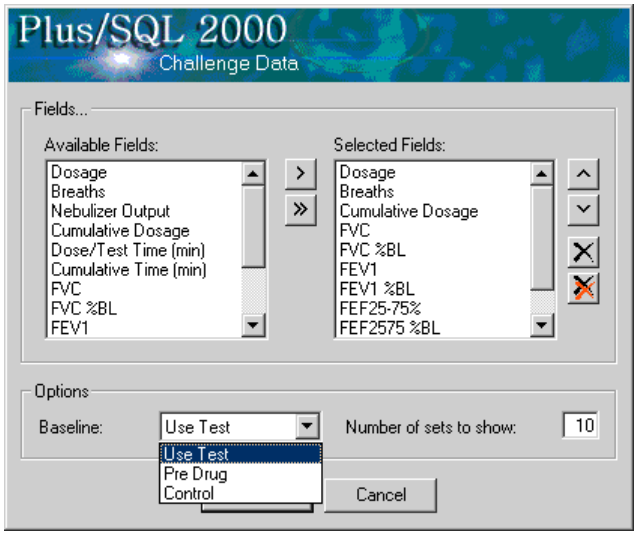



Figure 8-47. Selecting Fields for Challenge Data Section

5. The term *%BL* refers to Percentage of the Baseline for the accompanying parameter (e.g., FEV1 %BL)

6. Note that you can report the actual raw dosages or the cumulative dosages for each set. The American Thoracic Society recommends reporting cumulative dosages.

7. The *Dose/Test Time* refers to the time between the end of the dosage and the beginning of the test. The *Cumulative Time* refers to this time as it accumulates.

8. From the *Baseline* drop-down list, select which effort to use as the baseline:

   - *Pre-drug* refers to the reported Pre-Drug effort.
   - *Control* refers to the reported effort from the first level of challenge, usually the saline diluent.
   - *Use Test* refers to the baseline effort, either Pre-drug or Control, used during the actual challenge test.

9. Type in the number of challenge sets to show in this section, e.g., 10. If you have fewer actual levels than the number entered here, then of course only the actual number will display.

10. Select *Formatting* from the right-click menu to configure the appearance of the challenge text section.

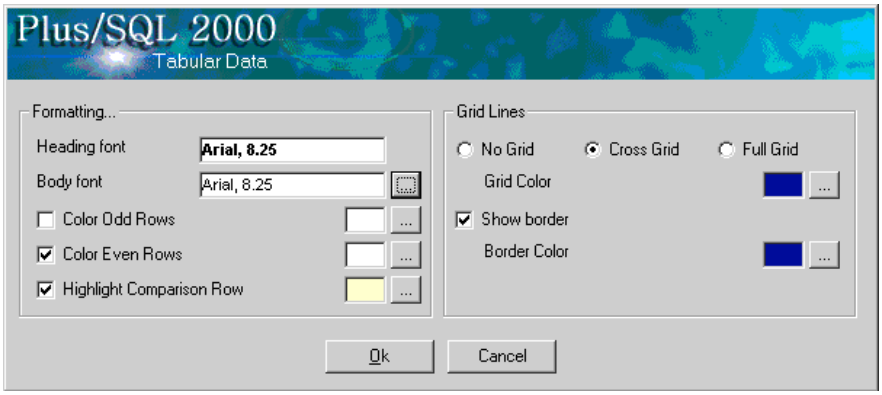



Figure 8-48. The Formatting Dialog for Challenge Data

11. Format the Fonts and row colors as described for the tabular data section. In addition, if you want to highlight the Comparison, i.e., the Baseline, check this box and format the color. Format the grid and border as described for the Tabular section.

12. Below is an example of a formatted Challenge Data section in Preview mode.

Challenge

| | Dosage | Breaths | Cumulative Dosage | FVC | FVC %BL | FEV1 | FEV1 %BL | FEF25-75% | FEF2575 %BL | FEFmax | FEFMax %BL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pre Drug | | | | 3.83 | | 3.24 | | 3.52 | | 9.13 | |
| Baseline | | 5 | | 3.81 | 100 | 3.20 | 100 | 3.37 | 100 | 8.98 | 100 |
| Set 2 | 0.065 | 5 | 0.3250 | 3.52 | 92 | 2.97 | 93 | 3.29 | 98 | 7.59 | 85 |
| Set 3 | 0.250 | 5 | 1.5750 | 3.52 | 92 | 2.96 | 93 | 3.26 | 97 | 8.39 | 93 |
| Set 4 | 1.000 | 5 | 6.5750 | 3.31 | 87 | 2.75 | 86 | 2.93 | 87 | 7.74 | 86 |
| Set 5 | 4.000 | 5 | 26.5750 | 2.24 | 59 | 1.85 | 58 | 1.95 | 58 | 4.10 | 46 |
| Set 6 | | 1 | | 3.73 | 98 | 3.11 | 97 | 3.31 | 98 | 8.87 | 99 |

Figure 8-49. Sample Challenge Data Section in Preview Mode

13. Note that in our example that we have added a text box for the Challenge label. We show both the Dosage and the Cumulative Dosage for comparison. The first challenge level is selected as the baseline and is highlighted. Otherwise we have not selected a color for either the odd or even rows. We've selected the Cross Grid and have selected the border.

**FVC Flow-Volume Graph**

1. Select FVC Flow-Volume Graph option from the Toolbox and drag the cursor on the page to draw this graph box.

   While you can size the flow-volume graph to fit an available space, be aware that the program will modify the height and width as needed to maintain the ATS-recommended 2-to-1 aspect ratio for plotting flow (y-axis) to volume (x-axis).

2. Right-click on the box to display the formatting options.

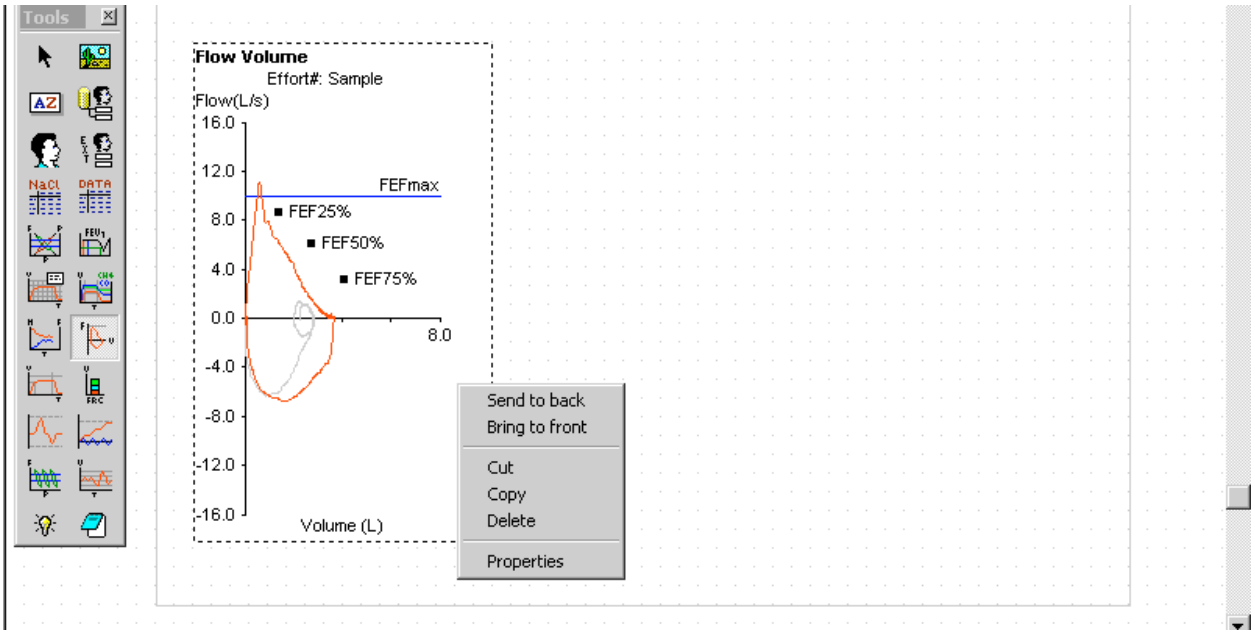



Figure 8-50. Formatting Options for the FVC Loop Section

3. From the menu select Properties. The properties dialog will display. There are five areas to configure: Title, Context, Graph Scale, Plot Color and Border Style.

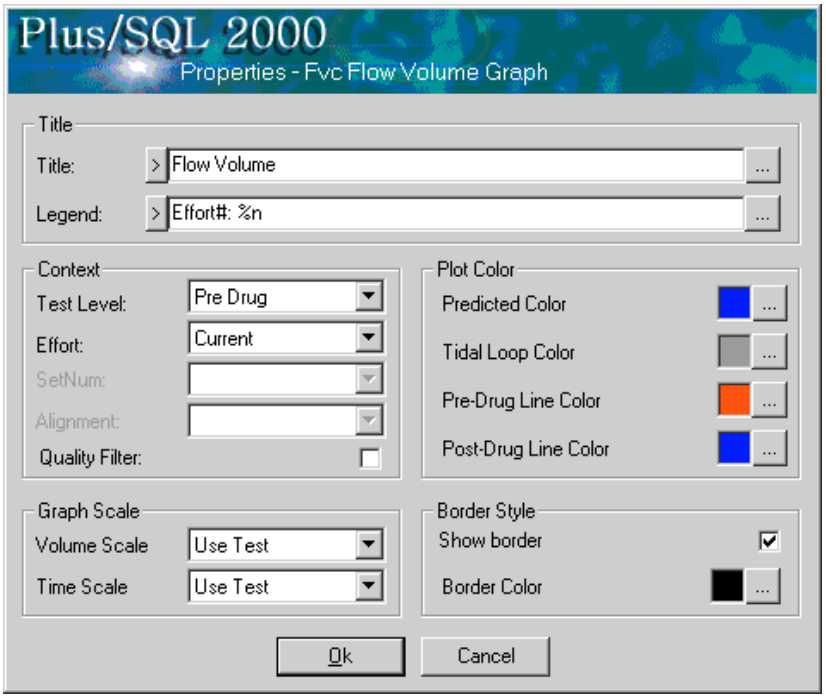



Figure 8-51. The FVC Loop Properties Dialog

4. To change the default title, *Flow Volume*, simply type in another title. Click on the > button next to Title. A drop-down menu of automatic fields will display.

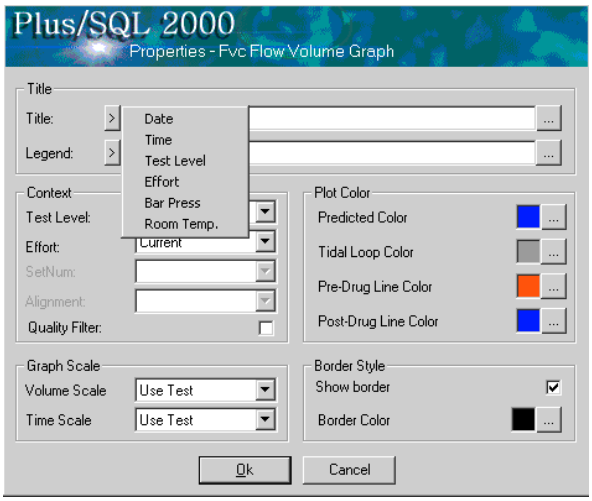



Figure 8-52. Menu of Field Options for the FVC Loop Title

5. To have the PLUS program automatically insert the Time, Date, Test Level, Effort number, BP or Room Temperature as part of the title, click on any number of these fields. The code for each field will display in the Title box. Insert the desired number of spaces in between the field codes. Keep in mind that if you have more than one tracing on a graph, as in an overlay, not all of the Legend data will display. For example, the date will just say NA.

6. Do the same for the Legend as you did for the Title. The Legend will appear below the Title in the heading above the graph.

7. For both the Title and the Legend, click on the ... button to format the font and color. Whatever you choose for the Legend will also apply to other graph textual items, such as axis labels.

8. Proceeding to the Context area of the dialog, click on the down arrow across from Test Level.

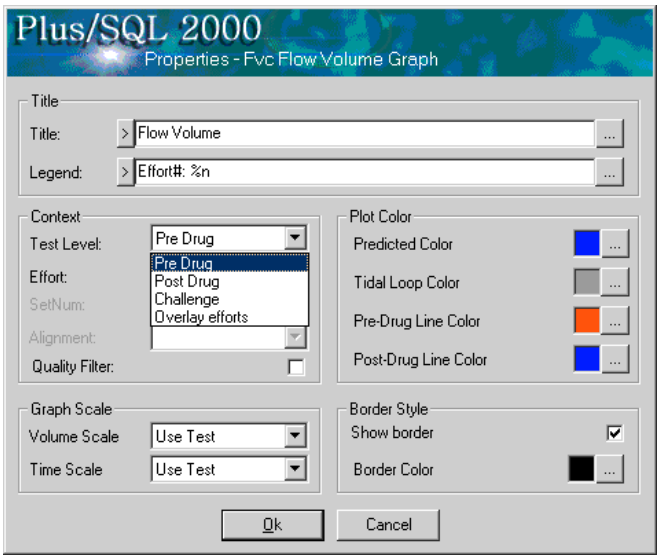



Figure 8-53. Selecting the Test Level for the FVC Loop

9. Select the desired test level, then the desired effort for the selected test level. If you want to display a single Pre- or Post-drug loop, this will be very straight-forward. Simply select *Pre* or *Post* for the Level; then select the number of the desired effort, or *Current* for the current effort. Keep in mind that, as with the Tabular section, the Effort Number does not necessarily correspond to the actual test effort number.

10. For the Test Level, select *Challenge* if you wish to display an effort from a specified challenge set. Select the Effort Number. Then select the desired set number. In the example below we have selected Effort number 2 from Set number 1. The loop for this effort will display when you click on OK and return to the Report page.

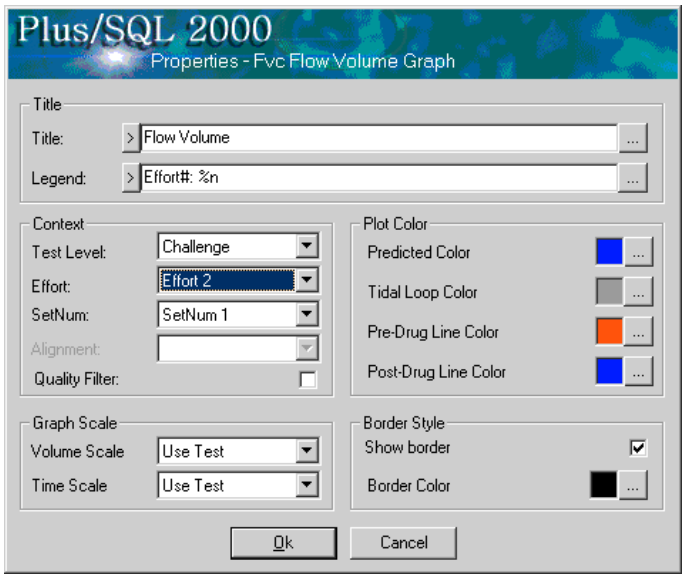



Figure 8-54. Selecting a Challenge Set Number and Effort Number for the FVC Loop Section

11. If you wish to overlay loops in order to compare them, select *Overlay efforts* for the Test Level. Then click the down arrow across from effort to display the Overlay options.

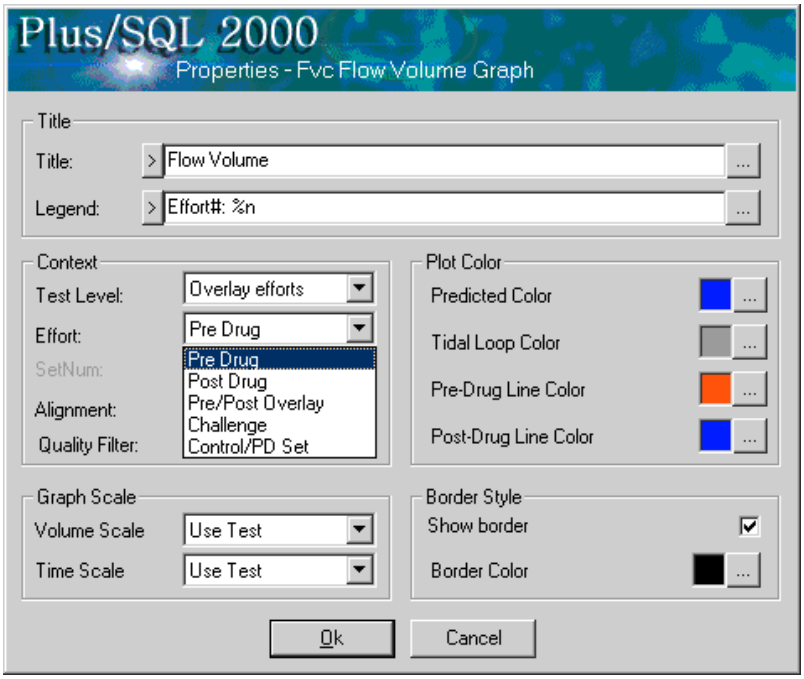



Figure 8-55. Overlay Options

12. Following is a description of each of the Overlay options:

- **Pre-Drug:** Overlays all the pre-drug FVC loops for the currently selected study.
- **Post-Drug:** Overlays all the post-drug FVC loops for the currently selected study. Here the term *Post* refers to the Post-drug mode (which is in set 0, along with Pre-drug), not the Challenge mode (sets 1 and up).
- **Pre-Post Overlay:** Allows you to overlay the reported pre-drug and the reported post-drug effort (both from level 0).
- **Challenge:** Overlays the reported tracing from each challenge set, including the Control set, which can be either the first challenge set or the pre-drug set, depending on technician selection during testing.
- **Control/PD Set:** Overlays the reported effort from the challenge control set with the reported effort from the challenge set where the greater than (20)% drop occurred.

13. Check off the box *Quality Filter* if you want to display only efforts that meet the ATS test specifications.

14. Select the Volume and Time scales to use for the FVC loop in the report. Each section has the option to use the same scale used at test time.

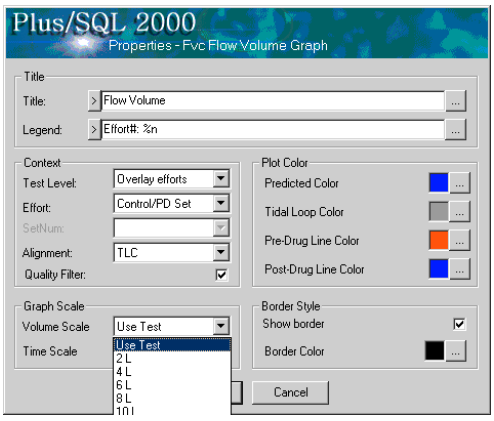



Figure 8-56. Selecting the Volume Scale for the FVC Loop

15. Select each plot color by clicking on the respective button to get the color dialog.

*Predicted Color* refers to the horizontal line on the FVC loop graph, which is the target line for FEFmax based on the current predicteds for the current patient. Predicted markers for FEF25, 50, 75% will also display on the graph.

*Pre-drug line* refers to the pre-drug tracing and

*Post-drug line* refers to the post-drug tracing.

*Tidal Loops* – The current default is to have the tidal loops grayed-out. You may choose a color for the tidal loops, or if you wish to not view them, select white.

Following is a sample overlay of Pre- and Post-drug loops.

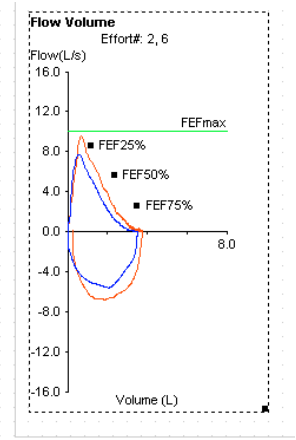



Figure 8-57. Sample Pre-Post FVC Loop Overlay

16. The Border Style selections are the same as for the report sections previously described.

17. When you've selected the desired properties, click on OK to return to the current report page.

**FVC Volume-Time Section**

1. Select the FVC Volume-Time option from the Toolbox and drag the cursor on the page to draw this graph box.

2. The FVC Volume-Time Section has the same property options as the FVC Loop section, including the ability to overlay selected tracings. In addition, you may change the default colors for the Pass and Fail indicators that display at the top of the graph (EV, EOT, TET).

   If you wish to turn off the quality indicators, set both Passed and Failed colors to the graph background color (usually white).

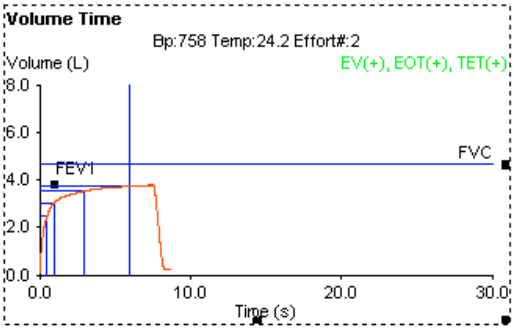



Figure 8-58. The FVC Volume-Time Graph Section

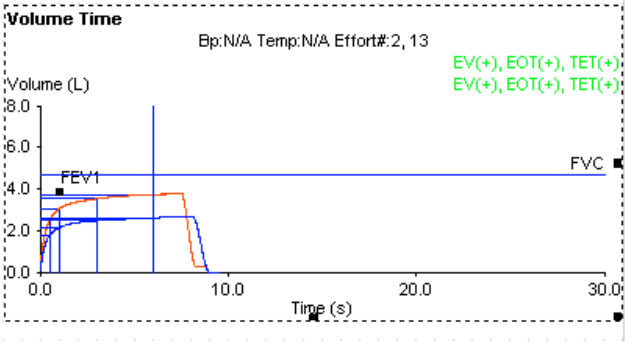



Figure 8-59. An FVC Volume-Time Overlay

**The Challenge Graph Section**

1. Select the Challenge Graph option from the toolbox and drag the cursor on the page to draw this graph box.

2. Right-click on the section to view the menu options.

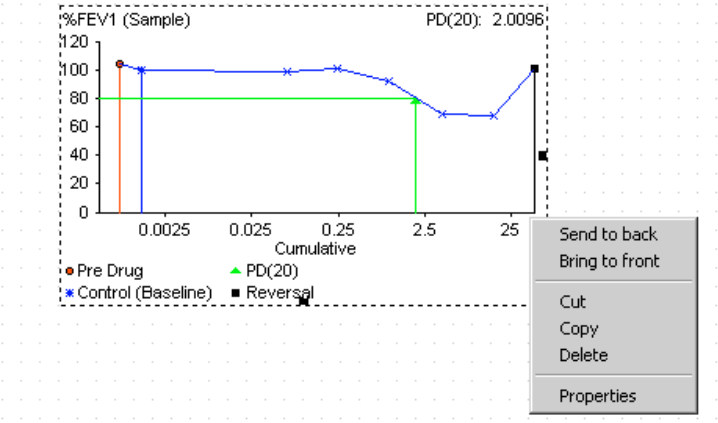



Figure 8-60. Challenge Graph Right-Click Options

3. Select Properties.

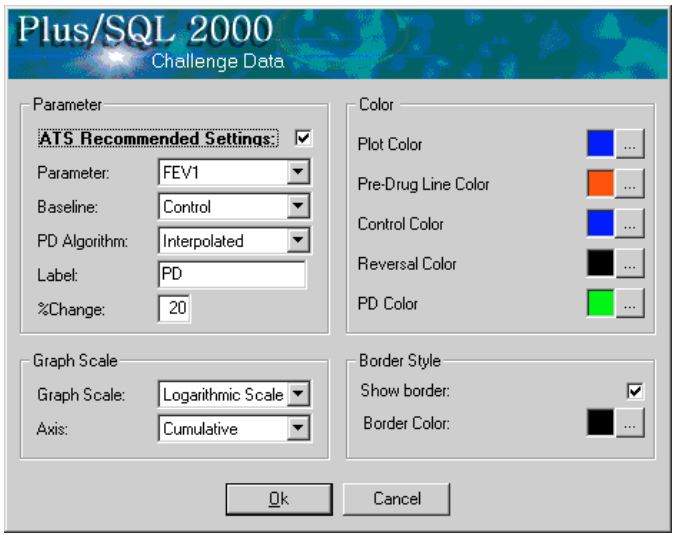



Figure 8-61. Challenge Graph Properties Dialog

4. Note that in the Parameters area, the box for *ATS Recommended Settings* is checked. This means that the values listed in the Parameters and Graph Scale areas meet ATS specifications for Challenge Testing. If you make any changes to these values, the ATS box will become unchecked. To change back to ATS settings, simply check the box again.

5. To change the observed Parameter for tracking the percent change, select one from the Parameter drop-down list.

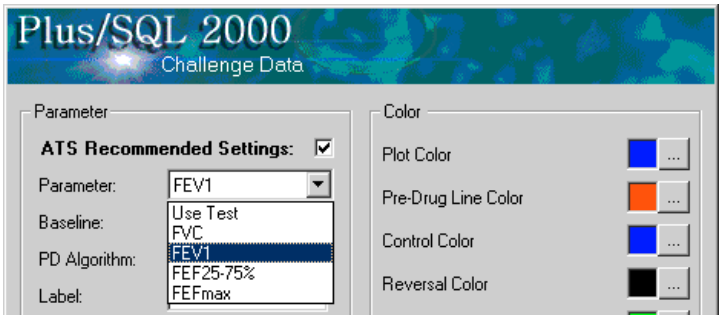



Figure 8-62. Changing the Observed Parameter for the Challenge Graph

6. To change the baseline, select an option from the Baseline drop-down list. The baseline options are described below.

- Pre-drug refers to the reported *Pre-Drug* effort.
- *Control* refers to the reported effort from the first level of challenge, usually the saline diluent if no dosage was entered.
- *Use Test* refers to the Baseline effort, either Pre-drug or Control, used during the actual challenge testing.

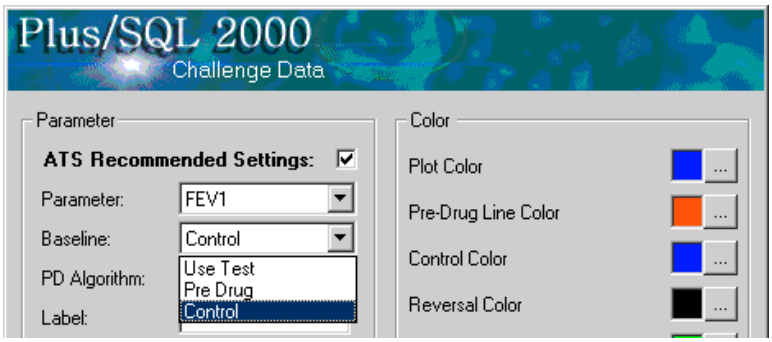



Figure 8-63. Selecting a Baseline Option for the Challenge Graph

7. The PD algorithm determines how the PD (provocative dosage) value is represented. To change the PD algorithm, select an option from the drop-down list.

   - If the *Dosage* option is selected, the raw dosage of the drug that resulted in a greater than the specified percent drop will be reported.

   - If the *Interpolated* option is selected, the program will use a linear interpolation algorithm to find the exact dosage between the last two dosages* that resulted in the greater than specified percent drop and report that value.

*** NOTE:**

The *dosages* referred to here are *cumulative* if the Cumulative option is selected for the x axis, or *dosages* if the Dosage option is selected for the x axis. See below.

The Interpolated option is used most commonly when the challenge agent is administered via a dosimeter.

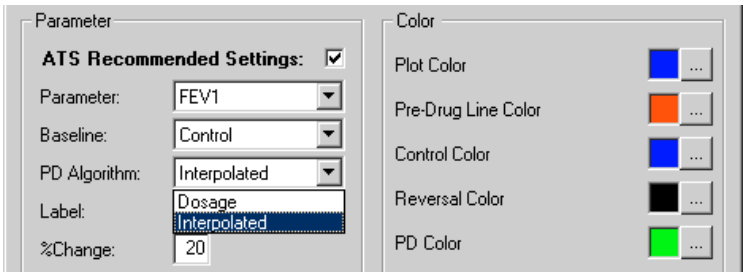



Figure 8-64. Selecting a PD Algorithm for the Challenge Graph

8. To change the label, PD (provocative dosage), simply type in another label. Some labs may prefer the label PC (provocative concentration). The parameter reported is called PD(20) or PC(20) as a matter of choice. The calculation for the interpolated challenge drug dose is the same for both PD and PC.

9. The Challenge section reports the dosage at which a specified percentage drop occurred in the observed parameter (e.g., $FEV_1$). If desired, type in a different percent of decrease in the %Change box.

10. *Graph scale* refers to the numeric scale of the x axis. To change the graph scale from logarithmic to linear, select *linear* from the drop-down menu.

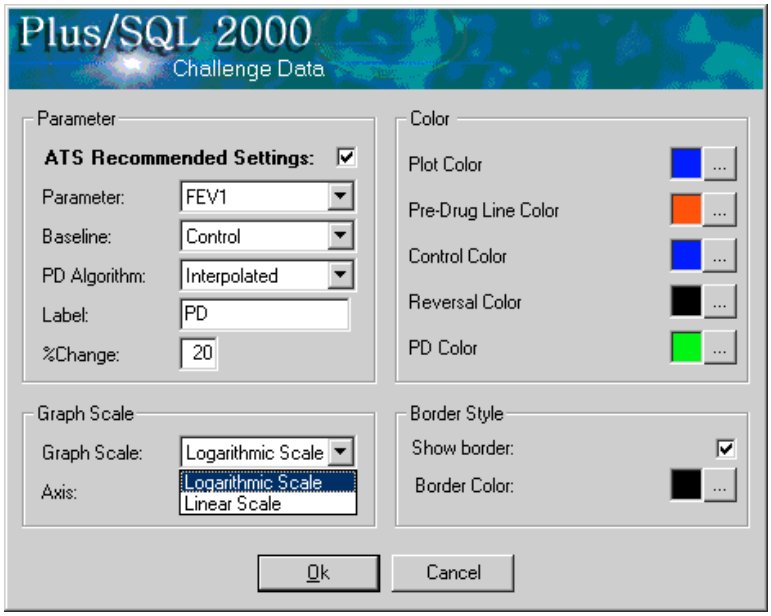



Figure 8-65. Selecting the Graph Scale for the Challenge Section

11. *Axis* refers to which data set to use when plotting the x axis. To change the axis from *Cumulative* to *Dosage*, make your selection from the drop-down menu.

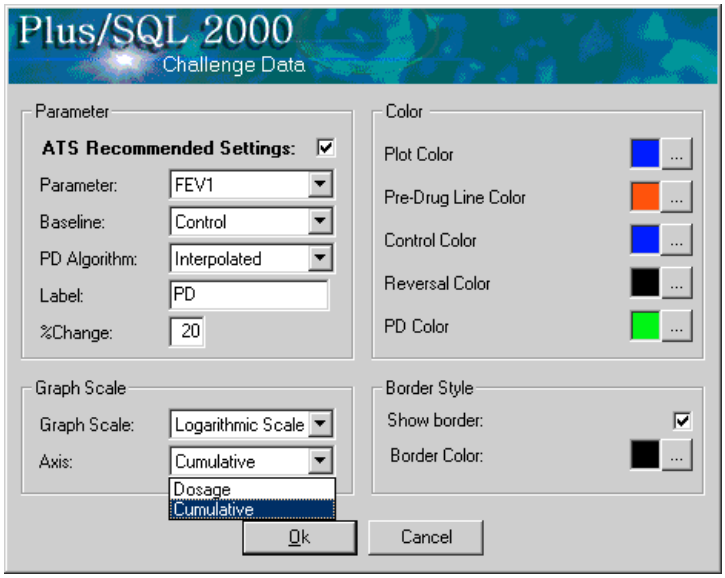



Figure 8-66. Selecting the Axis for the Challenge Graph

12. The next area is Color. You may change the following tracings or points by clicking on the corresponding button to get the color dialog:

- *Plot Color* – Color of the $FEV_1$ (or other parameter) tracing for the Challenge study.
- *Pre-drug Line Color* – Depicts the reported $FEV_1$ for the pre-drug effort
- *Control Color* – Depicts the reported $FEV_1$ for the control effort.
- *Reversal Color* – Point at the end of the graph representing where the reversal occurred.
- *PD Color* – Line color depicting the dosage at which the $FEV_1$ dropped by 20% (or other value).

13. The Border Style is the same as for other Extended Report sections.

**The MVV Graph Section**

1. To format the MVV graph section, click on the icon from the Toolbox. Drag the cursor on the page to draw this graph box.

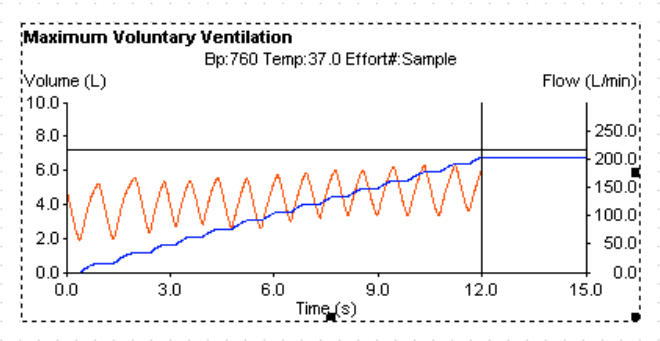



Figure 8-67. The MVV Graph Section

2. Right-click on the MVV section to get the menu options. Select Properties. The MVV Properties Dialog will display.

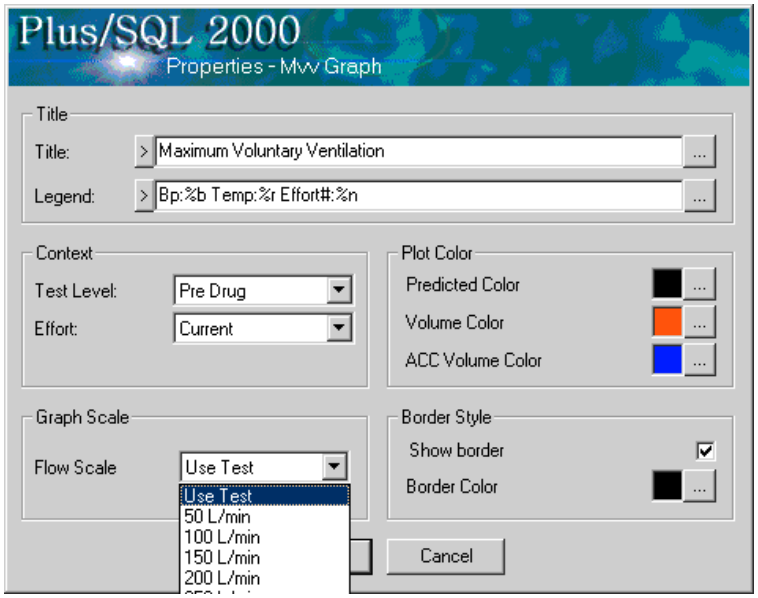



Figure 8-68. MVV Graph Properties

3. Most of the properties have been described in other text sections. You may select a graph to display from either the Pre- or Post-drug level. Adjust the flow scale as desired. Use the color dialogs to change the colors of the Volume Tracing, the target predicted line and the ACC (accumulated) volume tracing.

**The MIP/MEP Graph Section**

1. To format the MIP/MEP graph section, click on the icon from the Toolbox. Drag the cursor on the page to draw this graph box.

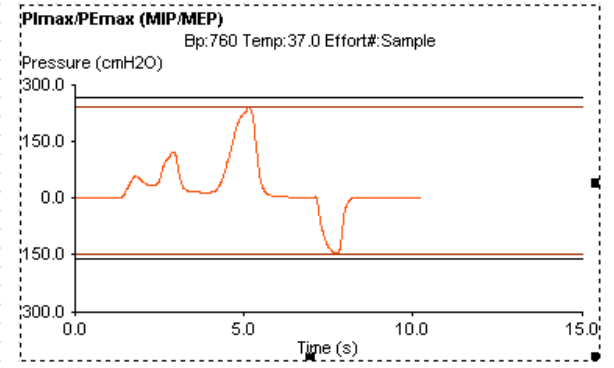



Figure 8-69. The MIP/MEP Graph Section

2. Right Click on the MIP/MEP graph section to get the context menu.

3. Select Properties. The Properties dialog will display.

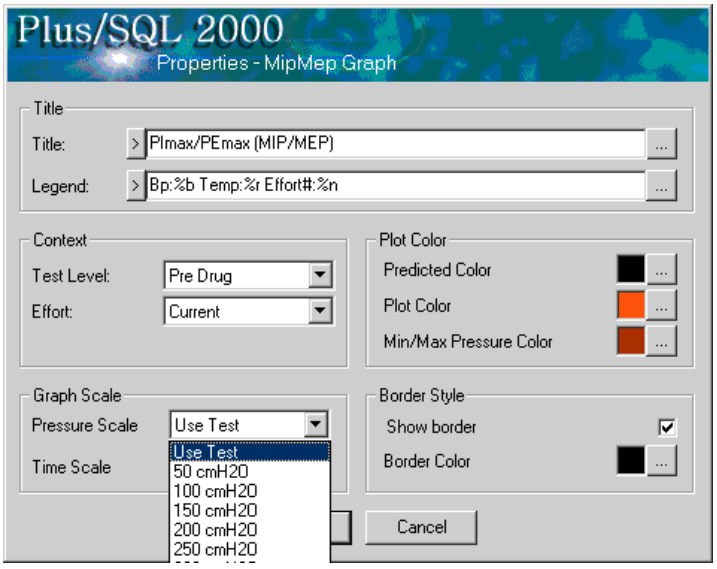



Figure 8-70. The MIP/MEP Graph Properties Dialog

4. Most of the options for the MIP/MEP graph are similar to those for the graph sections previously described. There are two test levels from which to choose, Pre-drug and Post-drug. After selecting the level, select the desired effort. Select a new pressure scale and time scale, if desired.

5. The Predicted Color refers to the horizontal lines representing the patient's target MIP and MEP based on the current predicted values. The Plot Color refers to the actual MIP/MEP tracing. The Min/Max Pressure Color refers to the horizontal lines representing the maximum MIP and MEP obtained during the test.

6. When finished formatting the MIP/MEP graph section, click on OK to close the MIP/MEP Graph dialog window.

**The FRC Graph Section (He dilution)**

1. To format the FRC graph section, click on the icon from the Toolbox. Drag the cursor on the page to draw this graph box.

2. Right click on the FRC graph section to get the context menu.

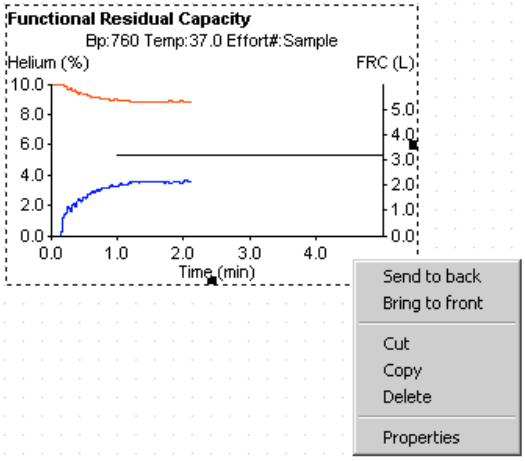



Figure 8-71. The FRC Graph Section with Right-Click Menu

3. Select Properties. The Properties dialog will display.

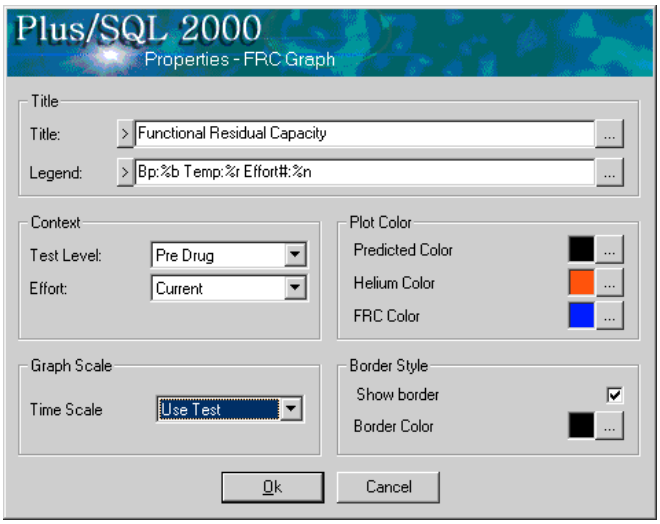



Figure 8-72. The FRC Properties Dialog

4. Most of the options for the FRC graph are similar to those for the graph sections previously described. There are two test levels from which to choose, Pre-drug and Post-drug. After selecting the level, select the desired effort. Select a new time scale, if desired.

5. The Predicted Color refers to the horizontal line representing the patient's target FRC based on the current predicted values. The Helium Color refers He concentration tracing. The FRC Color refers to actual FRC volume tracing.

6. When finished formatting the FRC graph section, click on OK to return to the report page.

**The Nitrogen Washout Graph Section**

1. To format the $N_2$ Washout graph section, click on the icon from the Toolbox. Drag the cursor on the page to draw this graph box.

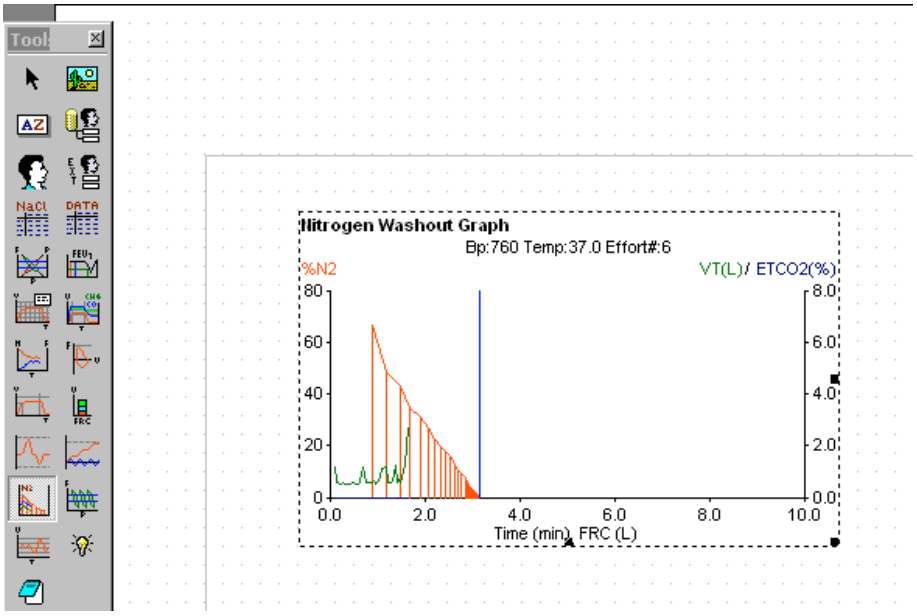



Figure 8-73. The $N_2$ Washout Graph Section

2. Right click on the $N_2$ Washout graph section to get the context menu.

3. Select Properties. The Properties dialog will display.

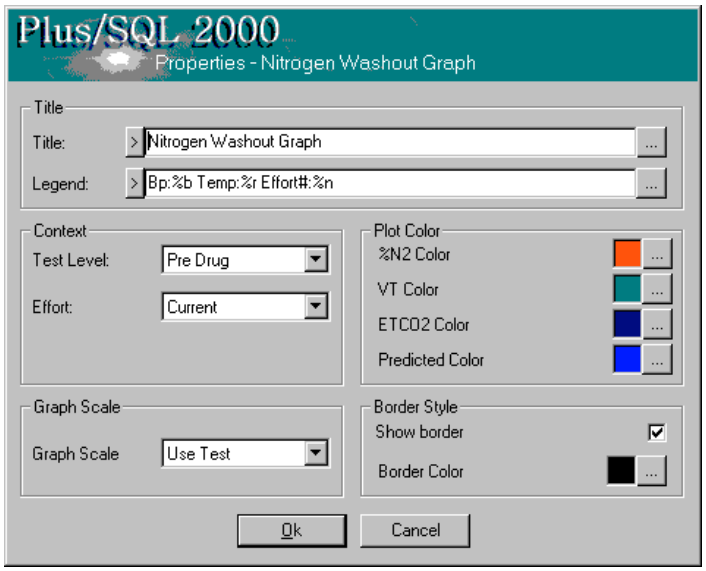



Figure 8-74. The $N_2$ Washout Graph Properties Dialog

4. Most of the options for the $N_2$ Washout graph are similar to those for the graph sections previously described. There are two test levels from which to choose, Pre-drug and Post-drug. After selecting the level, select the desired effort. Select a new graph scale, if desired. Select new colors for the $\%N_2$, VT, $ETCO_2$ and predicted tracings if desired.

5. When finished formatting the $N_2$ Washout graph section, click on OK to return to the report page.

**The DL Graph Section**

1. To format the DL graph section, click on the icon from the Toolbox. Drag the cursor on the page to draw this graph box.

2. Right Click on the DL graph section to get the context menu.

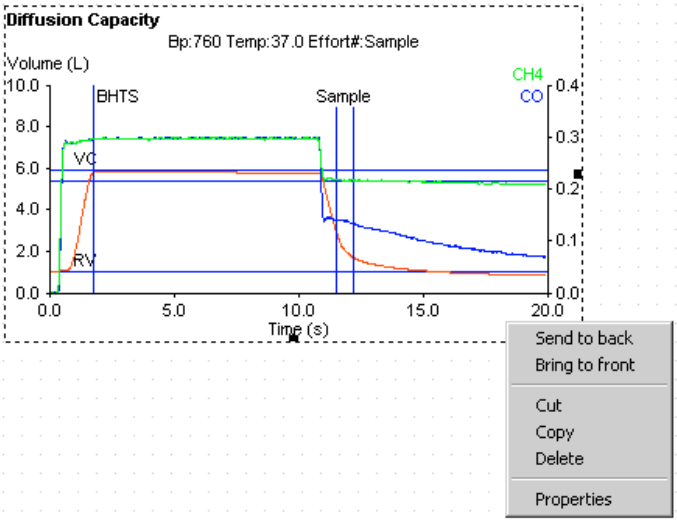



Figure 8-75. The DL Graph Section with Right-Click Menu

3. Select *Properties*. The Properties dialog will display.

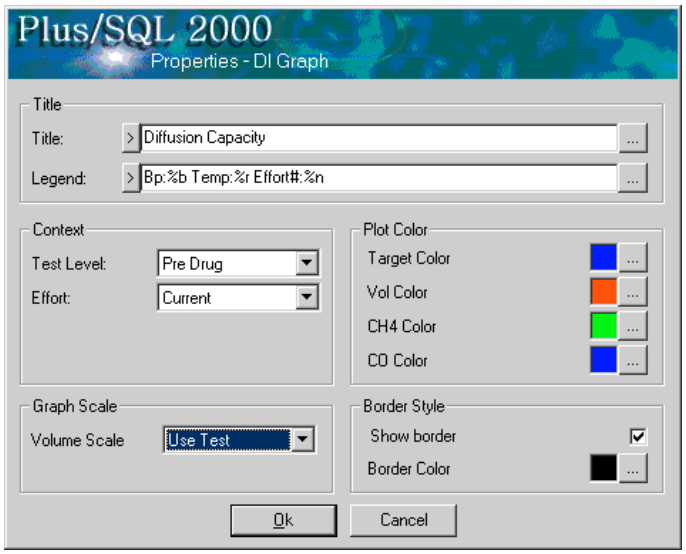



Figure 8-76. The DL Properties Dialog

4. Most of the options for the DL graph are similar to those for the graph sections previously described. There are two test levels from which to choose, Pre-drug and Post-drug. After selecting the level, select the desired effort. Select a new volume scale, if desired.

5. Change the tracing colors if desired. The Target Color refers to the horizontal lines representing the target area for the inspiratory portion of the Diffusion test. The Volume Color refers to the volume tracing. The CH4 and CO colors refer to the respective tracings for these gasses.

6. When finished formatting the DL Graph section, click on OK to close the DL Graph properties dialog window.

**NOTE:**
The Disability Graph section allows you to overlay DL tracings.

**The Disability Graph Section**

1. The Disability Graph is for the FVC and Diffusion tests. This must be the only graph on the page and must be printed on a landscape page (select the Landscape feature from the Page Setup option), as its size is dictated by Social Security Disability requirements. To show both an FVC and a Diffusion Disability graph on the same report, you will need to create two Disability graph sections, one for each of these tests, on two separate pages.

2. To format the Disability graph section, click on the icon from the Toolbox. Drag the cursor on the page to draw this graph box. Click OK for the message *Disability Graphs should be printed alone in a landscape page*. The disability graph will display. Note that the graph includes a window with demographic and calibration information.

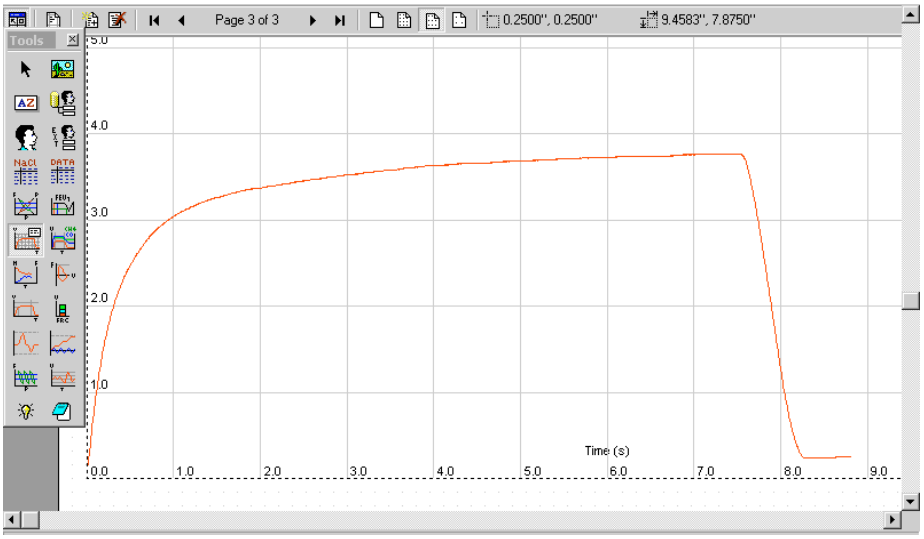



Figure 8-77. The Disability Graph Section

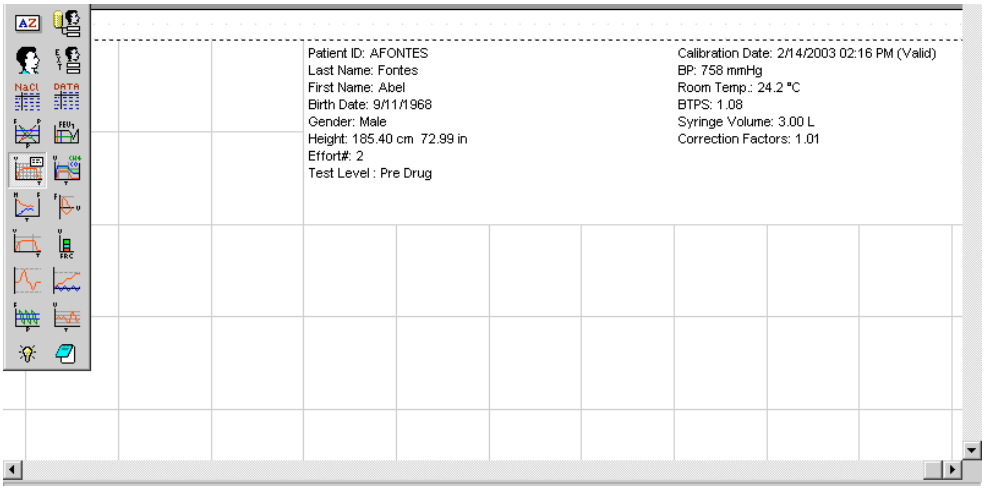



Figure 8-78. The Disability Data Window in the Disability Graph Section

3. Right Click on the graph to get the menu options. Then click on Properties. The Properties Dialog will display.

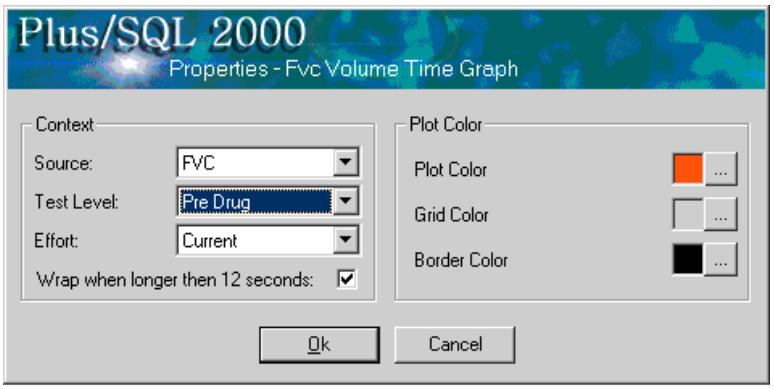



Figure 8-79. The Disability Graph Properties Dialog

4. From the Source drop-down menu, select the type of graph you want, FVC or DL.

5. Select the desired Test Level, Pre-drug, Post-drug or Overlay. Then select the desired Effort. If you have selected Overlay for the Test Level, the Effort menu will allow you to overlay all Pre-drug or all Post-drug efforts.

7. The scale for the Disability Graph is 12 seconds. If you want to display the remaining data for a test that lasts longer than 12 seconds, check the box for *Wrap when longer than 12 seconds*.

8. Plot color allows you to change the color of the Disability tracing. Grid color allows you to change the color of the background Grid. If you wish, change the Border color for the graph section. When done, click OK.

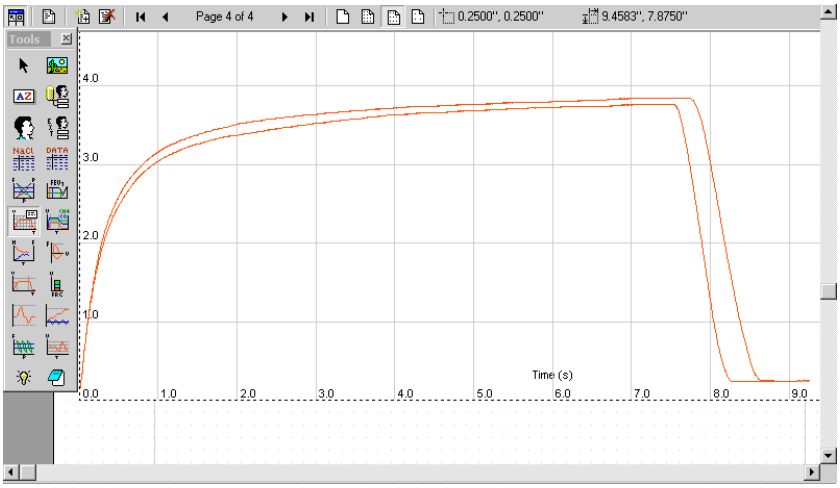



Figure 8-80. Sample Disability Graph with FVC Overlay

**The Lung Volumes Bar Graph Section**

1. The lung volumes bar graph shows the relationship between lung volumes and capacities and offers bar color options for the parameters RV, ERV and IC.

2. To format the bar graph section, click on the icon from the Toolbox. Drag the cursor on the page to draw this graph box.

3. Right-click on the bar graph section to get the context menu.

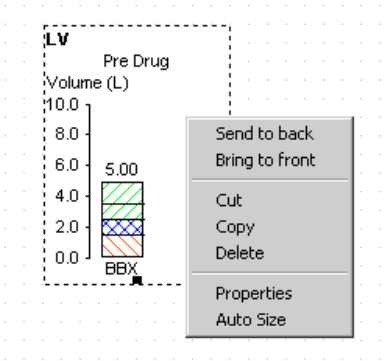



Figure 8-81. The Lung Volumes Bar Graph Section with Right-Click Menu

4. If you select Auto Size, the section will resize itself to the width of the graph, thus eliminating any extra space you may have creating in drawing the section.

5. Select Properties. The Properties dialog will display.

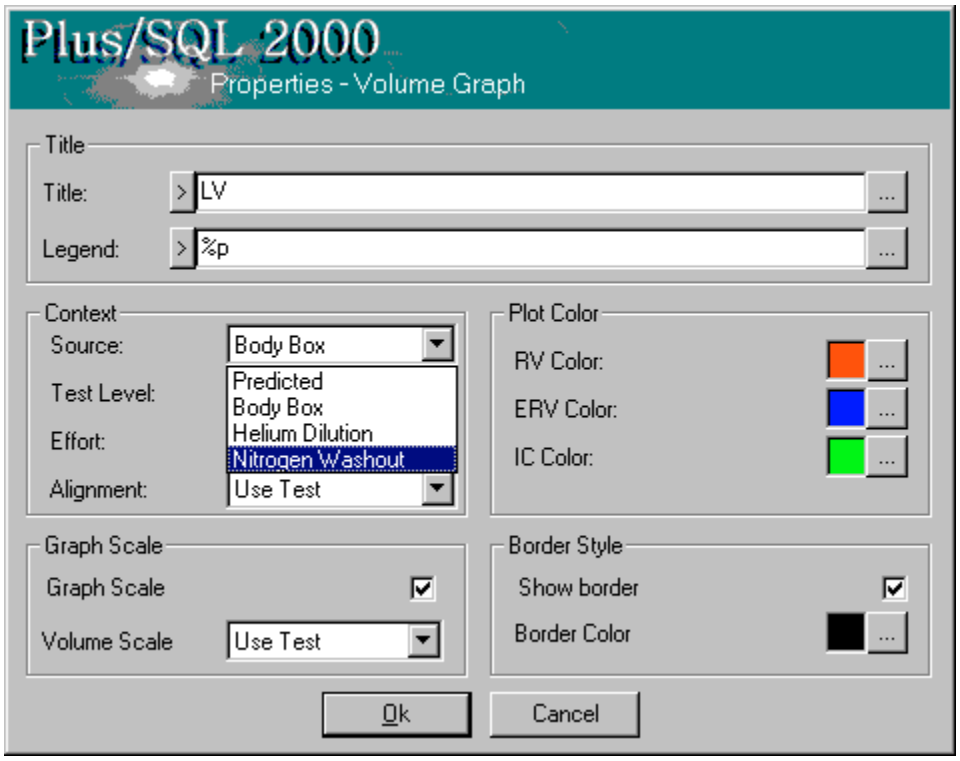



Figure 8-82. The Lung Volumes Bar Graph Properties Dialog

6. Select the *Title* and *Legend* fields as described previously for graph sections.

7. Select the source of lung volume data to use:

   *Predicted* – to view the predicted lung volumes for the current patient.
   *Body Box* – from body box testing on the current patient
   *He Dilution* – from a He gas dilution test on the current patient
   *Nitrogen Washout* – from an $N_2$ washout test on the current patient

   The bar graph will be labeled to indicate the selected data source.

8. Select the Test Level, Pre-drug or Post-drug. Note that if you have selected *Predicted* for the Source, the Test Level will not apply.

9. For the Effort, select *Current* or 1 through 8. Note that if you have selected *Predicted* for the Source, the Effort line will not apply.

10. Select how to align the graph. *Use Test* will align the graph at zero. *End–tidal* will align the graph at the end-tidal point. Aligning at end-tidal makes is easy to compare lung volumes from different efforts or the predicted with an actual effort. The value for Total Lung Capacity (TLC) will always be printed above the bar graph.

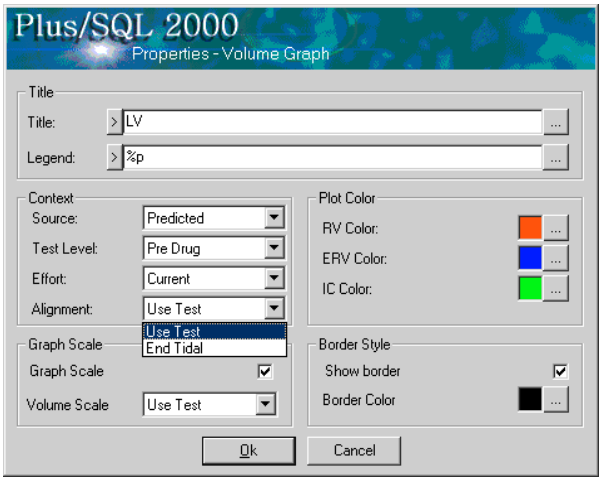



Figure 8-83. Selecting the Lung Volumes Bar Graph Alignment

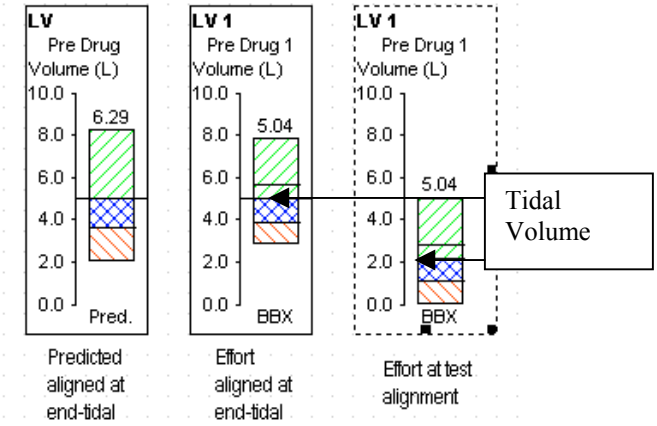



Figure 8-84. Example of Comparing Predicted and Actual Lung Volumes by Aligning at End-Tidal

11. To remove the graph scale on the Y axis, uncheck the box for Graph Scale.

12. To change the Volume Scale, select a different scale from the drop-down menu.

13. You may change the colors for RV (Residual Volume), ERV (Expiratory Reserve Volume) and IC (Inspiratory Capacity) by using the color dialog for each of these parameters as previously described

14. Select the Border options as previously described.

15. When done with the Properties dialog, click OK.

**The Volume Graph Section**

1. To view the volume graph from either SVC (He dilution), SVC ($N_2$ washout) or Body Box data, click on the icon from the Toolbox. Drag the cursor on the page to draw this graph box. Depending on which option is active, either the SVC tracing or the Body Box volume tracing will display.

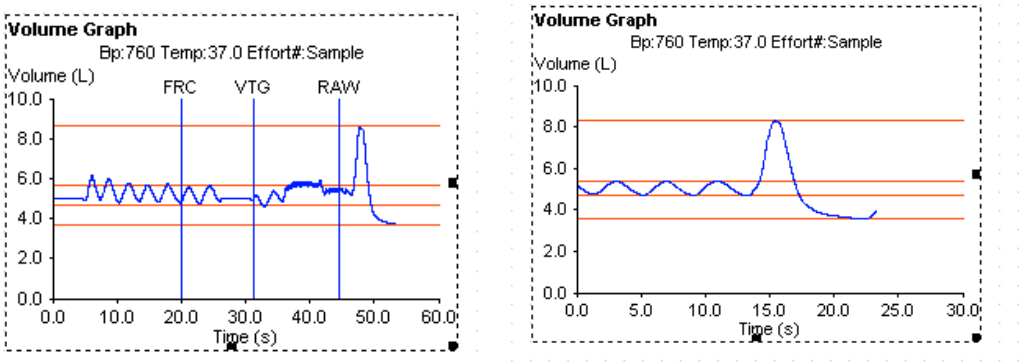



Figure 8-85. Volume Graph Section Showing BP and SVC Tracing Options

2. Right-click on the volume graph section to get the context menu.

3. Select Properties.

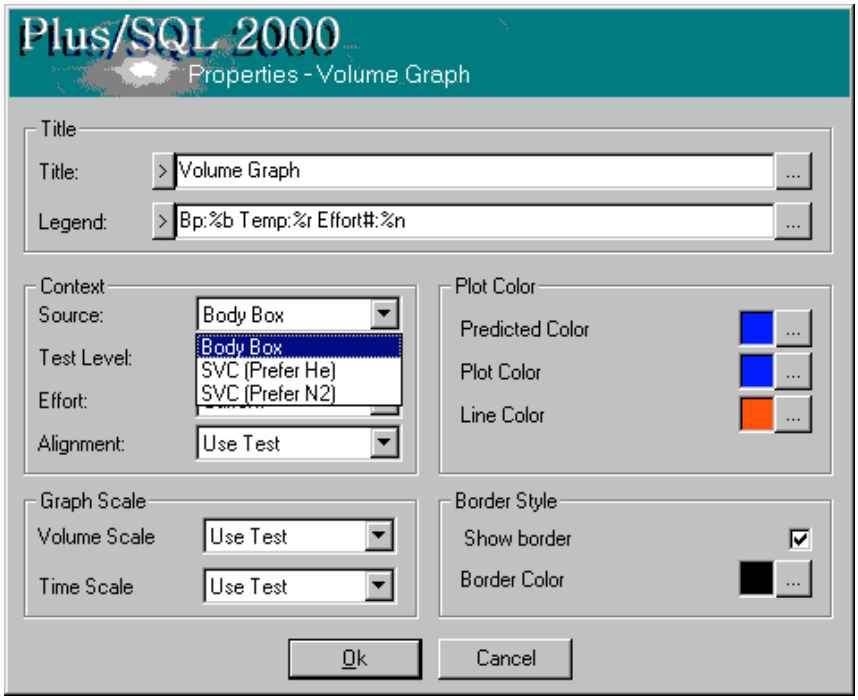



Figure 8-86. The Volume Graph Properties Menu

4. Make changes to the Title and Legend as described for previous graph sections.

5. Select the source of the volume data:

   Body Box Test
   SVC test conducted in the He Dilution module. If the He data is not available, the $N_2$ data is used.
   SVC test conducted in the $N_2$ Washout module. If the $N_2$ data is not available, the He data is used.

6. Select the desired Test Level: Pre-drug or Post-drug.

7. For the selected Test Level, select the desired effort, either the Current or 1 through 8.

8. Select the preferred volume scale alignment, at RV or at the test volume. Aligning at RV makes is easy to compare lung

volumes from different efforts. Following are examples of alignment at the test volume and at RV for both an SVC effort and a Body Box effort.

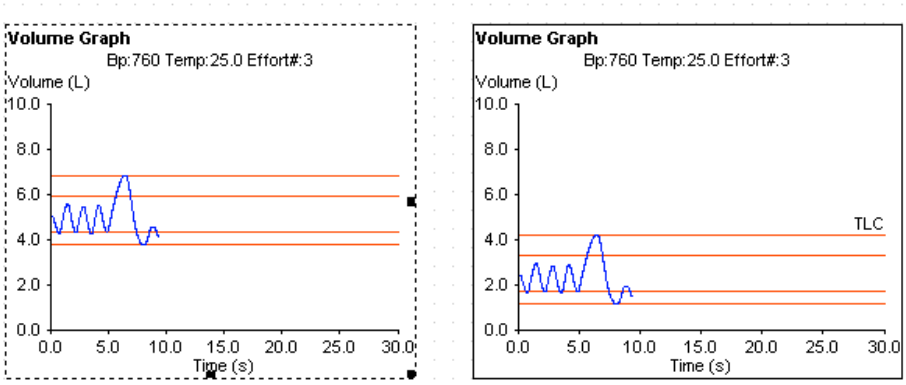



Figure 8-87. Examples of Volume Alignment at Test Level (left) and at RV for SVC Test

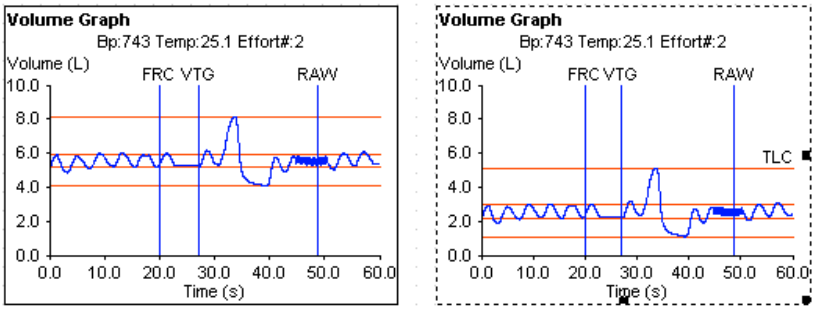



Figure 8-88. Examples of Volume Alignment at Test Level (left) and at RV for Body Box Test

9. To change the Volume or Time Scale for the volume graph, select the desired option from the appropriate drop-down menu.

10. Change the Plot colors by using the color dialog for each of these parameters as described for previous graph sections.

- Predicted (Time Lines) – On the Body Box tracing, the vertical lines that mark the volume history where the FRC, VTG and RAW measurements were taken.
- Plot – Refers to the volume history tracing
- Line – Refers to the horizontal lines denoting various lung volumes.

11. Select the Border options as previously described.

**The Body Box Raw Graph Section**

1. The Box Raw Graph Section enables you to separate the individual breath tracings in a Raw graph and adjust the target lines for each breath individually. To select this option, click on from the Tools menu. Drag the cursor on the page to draw this graph box. The Raw Graph section will display as follows:

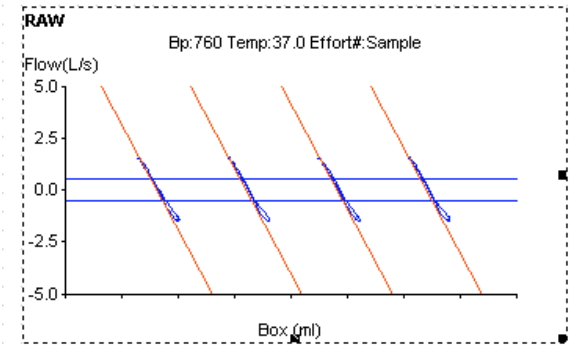



Figure 8-89. The Raw Graph Section

2. Right-click on the Raw graph section to display the options menu.

3. Select Properties. The Properties dialog will display:

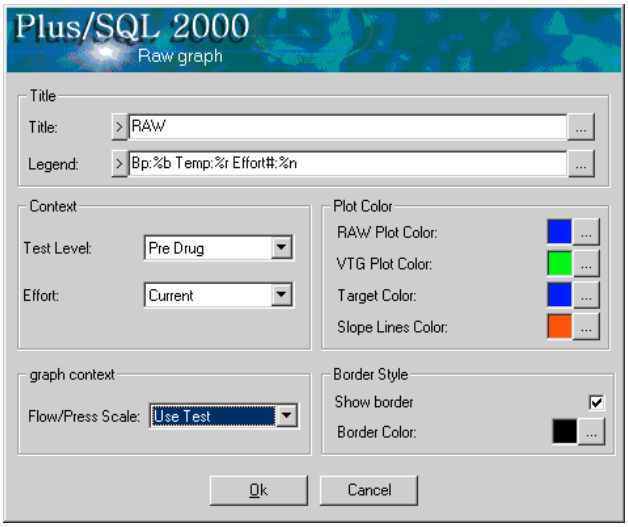



Figure 8-90. The Raw Graph Properties Dialog

4. Make your selections from the Properties dialog as described for previous sections.

5. The Plot Color options can be described as follows:

**Raw Plot Color:** The color of the actual Raw loops.
**VTG Plot Color:** Active in the VTG graph. Not active in the Raw Graph section.
**Target Color:** Refers to the horizontal lines on the graph, at plus and minus .5 liters per second, used as a target zone for fitting the tangent line.
**Slope Line Color:** Refers to the line indicating the slope formed by the Raw tracing.

6. When finished selecting the section options, click OK. The figure below shows a sample Raw graph section in Preview mode.

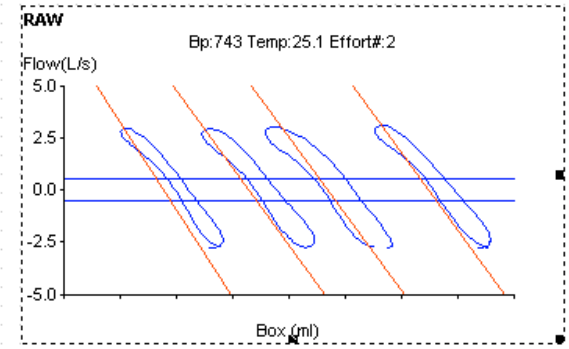



Figure 8-91. Sample Raw Graph in Preview Mode

**The Body Box Composite Graph Section**

1. To select the Body Box Composite Graph Section, click on from the Tools menu. Drag the cursor on the page to draw this graph box. The Composite Graph section will display as follows:

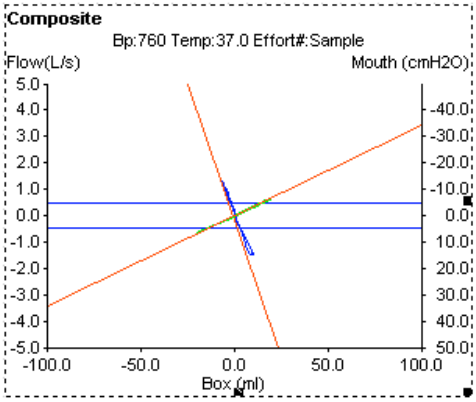



Figure 8-92. The Body Box Composite Graph Section

2. Right-click on the section to display the options menu. Select Properties. The Properties dialog will display.

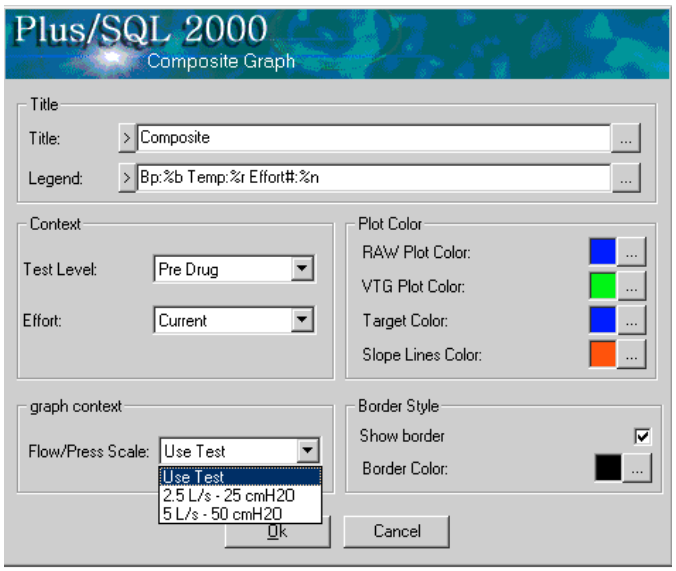



Figure 8-93. The Body Box Composite Graph Properties Dialog

3. Make your selections from the Properties dialog as described for previous sections.

4. The Plot Color options can be described as follows:

   **Raw Plot Color:** The color of the Raw tracing.
   **VTG Plot Color:** The color of the VTG tracing.
   **Target Color:** Refers to the horizontal lines on the Raw graph, at plus and minus .5 liters per second, used as a target zone for fitting the tangent line.
   **Slope Line Color:** Refers to the lines indicating the slope formed by the Raw and the VTG tracings.

5. When finished selecting the section options, click OK. The figure below shows a sample Composite graph section in Preview mode.

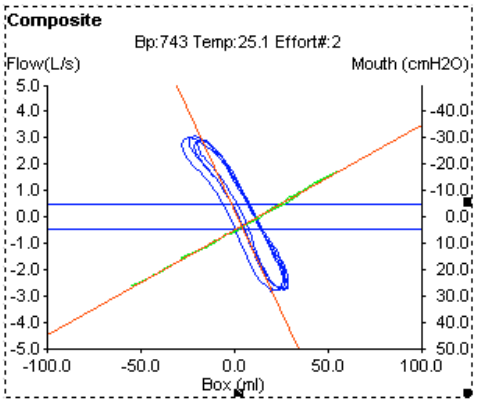



Figure 8-94. The Body Box Composite Graph Section in Preview Mode

**The Interpretation Section**

1. The Interpretation Section allows you to print the computerized interpretation for the current patient study. Extended Ellis is always the default interpretation program. You may also select either the standard Ellis interpretation or a user-created interpretation.

2. To select the Interpretation Section, click on from the Tools menu. Drag the cursor on the page to draw this section box. Keep in mind that your section must be large enough to encompass the entire Interpretation output. Otherwise, it will be cut off and *not* continued onto another page.

3. Right-click on the section to get the options menu.

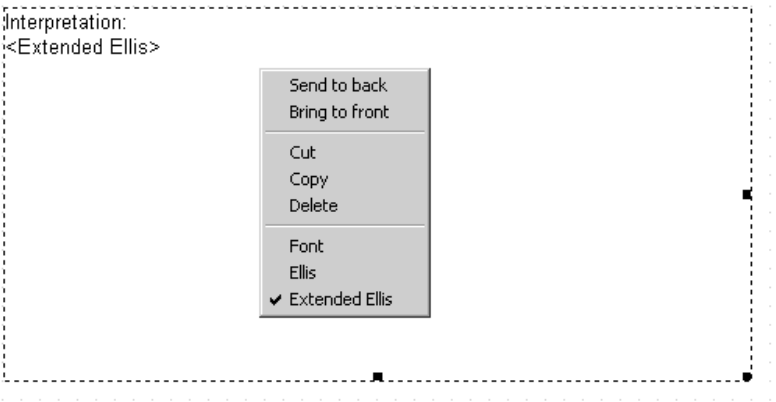



Figure 8-95. The Right-Click Options for the Interpretation Section

4. To change the Interpretation font, select *Font*.

5. To change the interpretation to either the Ellis interpretation, the Extended Ellis interpretation, or any user-created interpretations from the Interpretation Editor, click on the desired option. The label indicating the interpretation name at the top of the Interpretation section will change accordingly.

6. All other right-click menu options are the same as described for previous Extended Report Sections.

7. To display the actual computerized interpretation, select Preview. Following is an example.

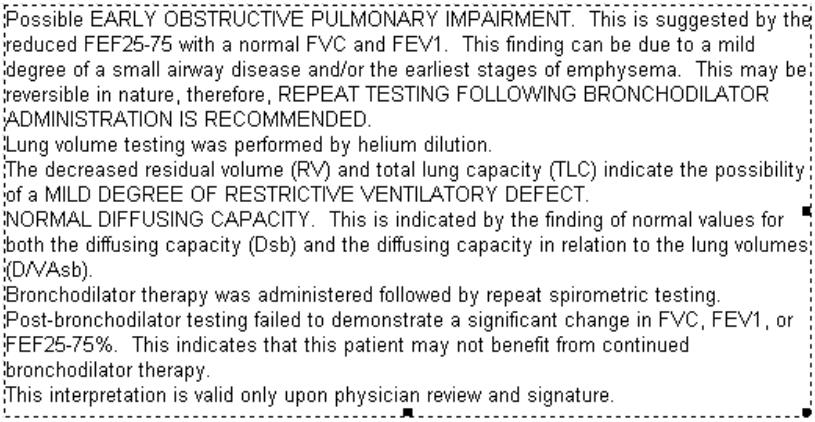

Possible EARLY OBSTRUCTIVE PULMONARY IMPAIRMENT. This is suggested by the reduced FEF25-75 with a normal FVC and FEV1. This finding can be due to a mild degree of a small airway disease and/or the earliest stages of emphysema. This may be reversible in nature, therefore, REPEAT TESTING FOLLOWING BRONCHODILATOR ADMINISTRATION IS RECOMMENDED.
Lung volume testing was performed by helium dilution.
The decreased residual volume (RV) and total lung capacity (TLC) indicate the possibility of a MILD DEGREE OF RESTRICTIVE VENTILATORY DEFECT.
NORMAL DIFFUSING CAPACITY. This is indicated by the finding of normal values for both the diffusing capacity (Dsb) and the diffusing capacity in relation to the lung volumes (D/VAsb).
Bronchodilator therapy was administered followed by repeat spirometric testing.
Post-bronchodilator testing failed to demonstrate a significant change in FVC, FEV1, or FEF25-75%. This indicates that this patient may not benefit from continued bronchodilator therapy.
This interpretation is valid only upon physician review and signature.

Figure 8-96. The Interpretation Section in Preview Mode

**The Notes Section**

1. The Notes section allows you to display the technician or physician notes created in the Notes program for the current patient study.
2. To select the Notes section, click on from the Tools menu. Drag the cursor on the page to draw this section box.

3. Right-click on the Notes section to get the options menu.

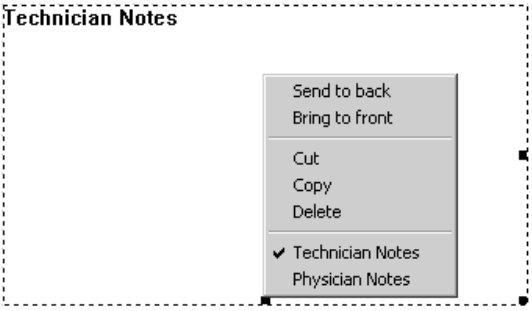



Figure 8-97. The Right-Click Menu for the Technician Notes Section

4. Select the Technician or Physician Notes created in the Notes program. The selected category will display at the top of the section. You cannot display both Technician and Physician notes in one section. You must have a separate Notes section for each of them.

5. Following is a sample Notes section in Preview mode.

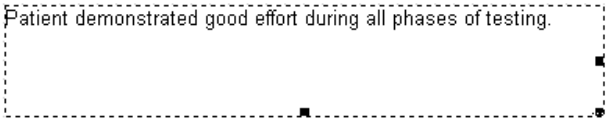



Figure 8-98. Sample Notes Section in Preview Mode

This concludes the Extended Reports description. For more new PLUS/2000 features, continue.

**Physician Review**

1. The Physician Review feature is available for Extended Report files (extension .xrd). This option allows you to enter text into the Notes section while reviewing a patient report. The Notes section of the report will be updated with the new text whenever you click on Save.

2. First make sure the desired patient is current. From the GoTo menu, select Physician Review. The program will display the opening screen with the Notes window. If Notes is not displayed, click on the Notes button in the program bar, next to the GoTo button.

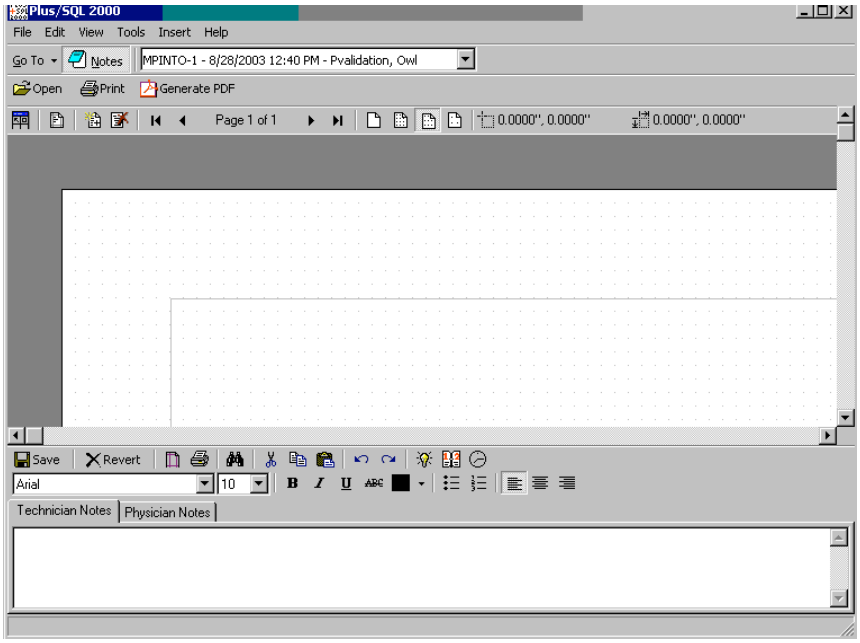



Figure 8-99. Physician Review Opening Screen

3. To open a report to review, click on the Open icon

at the top left of the window.

4. The program will display the Open Extended Reports Definition dialog.

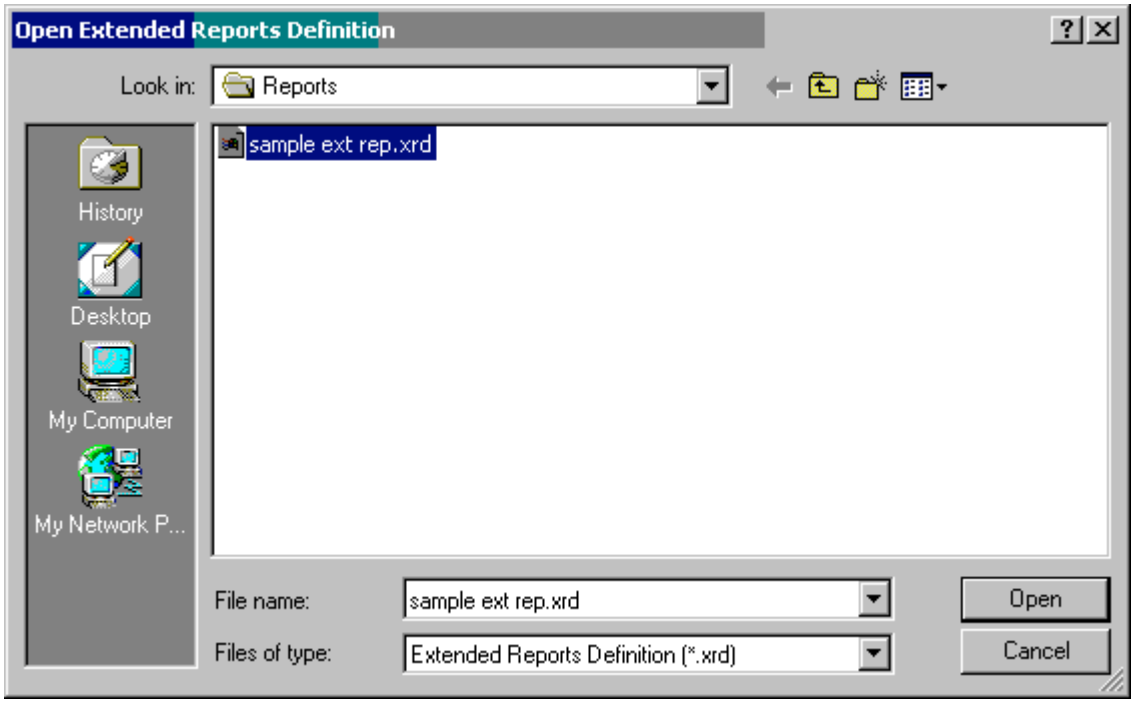



Figure 8-100. Opening an Extended Report Definition

5. Open the desired report definition for the current patient. The report will appear in the background, behind the Notes editor.

**NOTE:**
If a default Extended Report is selected under *Tools, Configuration, General Tab*, it will automatically open when you select Physician Review.

6. Use the scroll bars to navigate through the report while typing in Technician or Physician notes in the editor as desired. Note that you may not edit the patient report, other than the Notes, in this option. You must access Extended Reports in order to do so.

7. When you save the Notes, they will be added to the Notes section of your report. In order for them to display in the report, you must have created a Notes section in the report definition. If you wish to see how they appear in the report, scroll to the point where you can see the Notes section.

**NOTE:**
When you access this report in Extended Reports, you must be in the Preview Mode in order to see the actual Notes entered.

8. When done with the review, click on Save to save the notes. Click on GoTo to access other areas of the program.

9. If a default Extended Report is selected under Tools, Configuration, General Tab, it will automatically open when you select Physician Review.

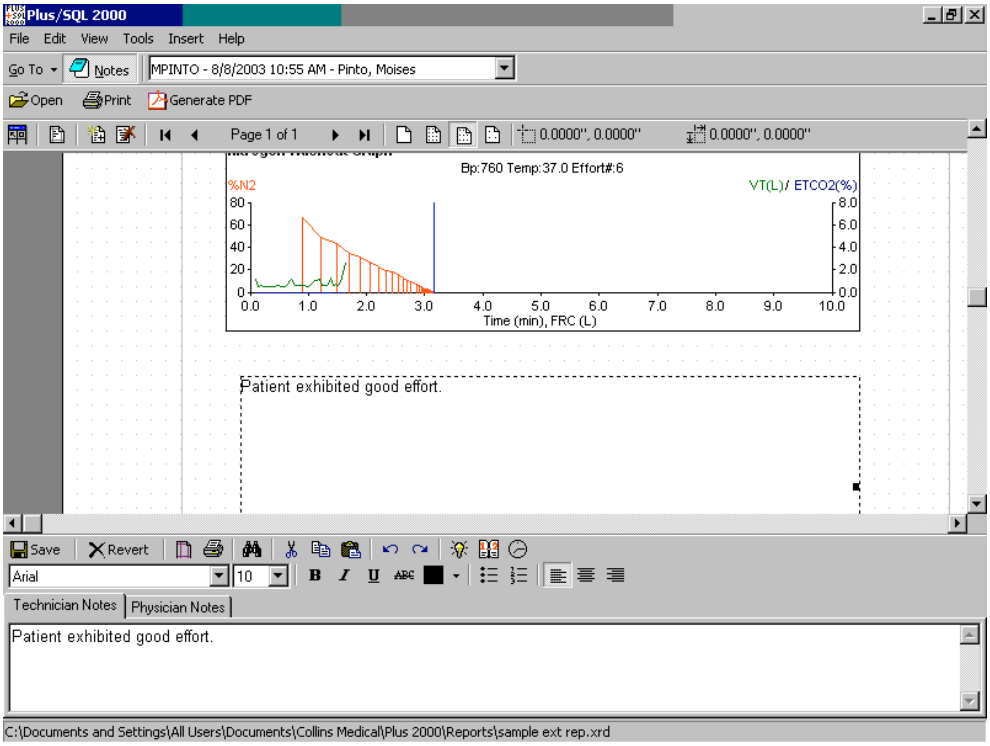



Figure 8-101. Entering Notes in Physician Review

## Printing Reports

1. To print a report, click on *File*, then *Print Report*.

2. A default report file, as designated in General Configuration, should display in the Report Generator window next to *Selected Report*.

3. If no report displays, or if you want to change the current report definition, click on the dotted button next to the bar. A standard Windows® file search window will display.

4. Click on the down-arrow for *Files of Type*. The following options will display:

   **Report Definitions (*.frd,*.xrd) -** Selecting this option will display the available report files for Standard report (*.frd) and Extended (*.xrd) report definitions. The Standard report refers to definitions created in *Report Designer,* on the GoTo menu.
   **Final Report Definitions (*.frd)** - This option refers to the type of report defined in *Report Designer* on the GoTo menu.
   **Extended Report Definitions (*.xrd)** - This option refers to the type of report defined in *Extended Reports* on the GoTo menu.
   **All Files (*.*)** - Selecting this option will display all files in this folder.

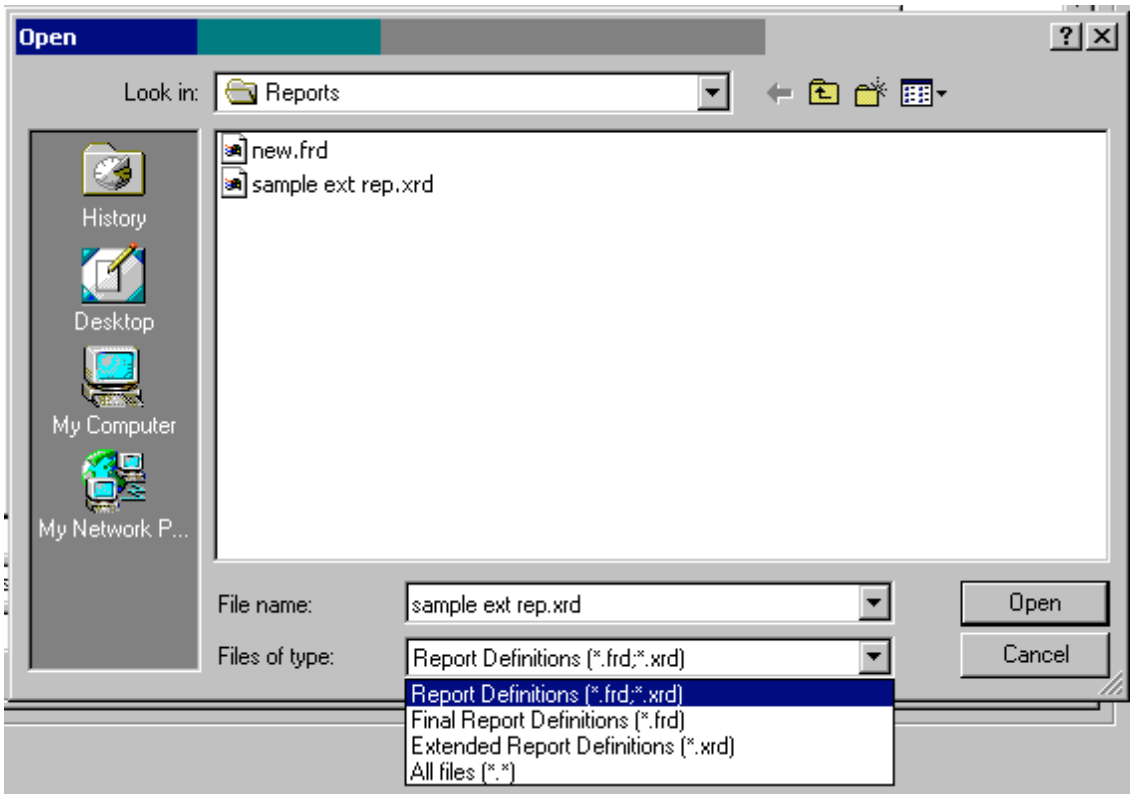



Figure 8-102. Selecting the Type of Report to Print

5. Select the desired file type and search for the desired report files. Report files are normally stored in C:\Program Files\Collins Medical\Plus2000\Reports.

6. Double-click on the desired report file; this file name will now display as the selected Report definition in the Report Generator.

7. Now that you have selected a report definition, you must select a patient study or studies to print.

8. The patients currently listed in your Patient Cache will display in the window. If you want reports to print for all of these patients in automatic succession, click on *Select All*. Checkmarks will appear in the boxes next to all the patient studies.

9. If you wish to print reports on a select number of patients or just one, click on the desired boxes to select them. Click again to de-select a study if you change your mind.

10. You may click on Preview to preview the report for the highlighted study on the screen before printing it.

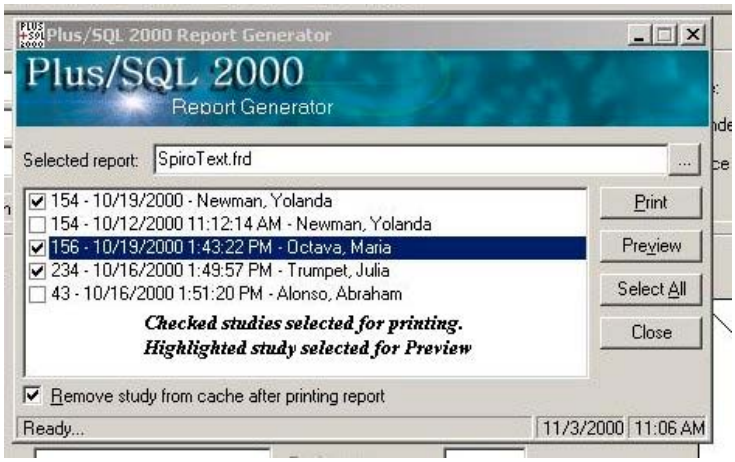



Figure 8-103. Selecting a Report Definition for Printing

11. When ready to print, click on Print.

12. In General Configuration you may select a default final report to print. This is the report that will print unless otherwise selected at printing time.

## Exiting the PLUS/2000 Program and Powering Down the System

1. In order to exit the PLUS program, click on File and then Exit, or click on the boxed *X* in the upper right corner of the screen. The program will shift to the Windows® Desktop.

2. In order to power down, select Start, followed by Shut Down. The computer will either power down automatically or the program will instruct you on when it is safe to power down the computer.

3. Turn off the power to the monitor, printer, CPL or other test device, etc.

## SECTION NINE – CPL DIAGNOSTIC SOFTWARE

The CPL Diagnostics program enables the user to check the condition of the balloons in the balloon valve, perform a conditioning procedure on replacement balloons, and perform both static and dynamic leak testing without risk of damaging the system.

### Accessing CPL Diagnostics

1. To access CPL Diagnostics, click on the *Start* button to the left of the Task bar; then select Programs, PLUS/2000 and CPL Diagnostics.

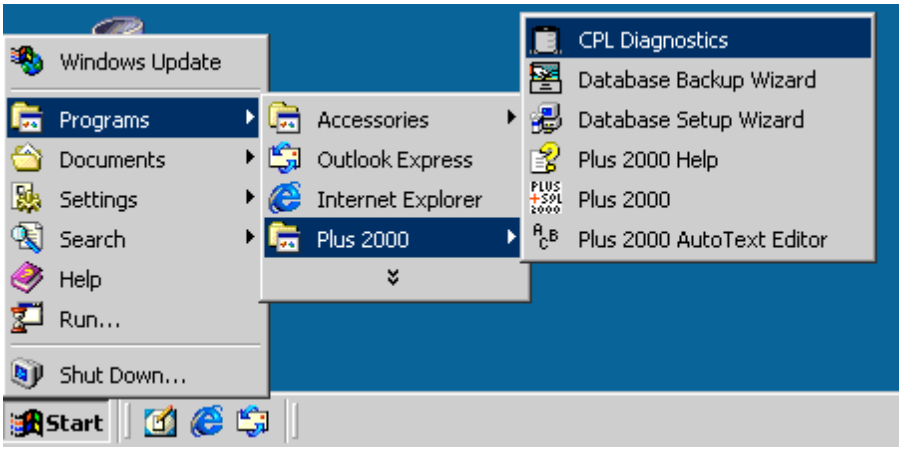



Figure 9-1. Accessing CPL Diagnostics

2. The program will display a series of tabs that allow you to run self-describing diagnostic routines.

3. From the drop-down menu, select the component on which you wish to run diagnostic routines. In this case we have selected the CPL with the USB interface, CPL (SN:X2002). If you attempt to perform any of the diagnostic functions without selecting a device, an error message will be displayed instructing you to select a device before you can proceed.

### Checking the Valve Balloons

1. Select the tab *Check Balloons*.

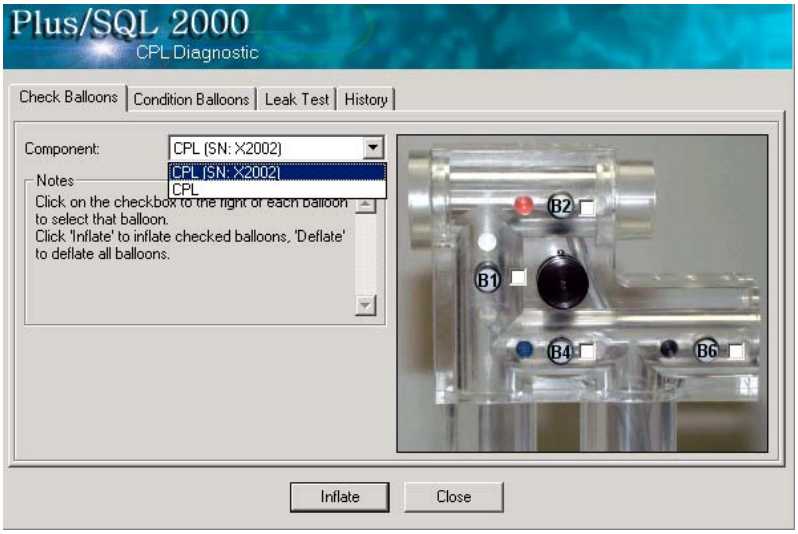



Figure 9-2. Selecting a Component and Checking the Balloons

2. In the picture of the balloon valve at the right of the dialog are white boxes next to each of the balloons. Clicking on an empty box will insert a checkmark into the box; clicking on a checkbox displaying a check will remove the checkmark. Click on the boxes next to the balloons you wish to check. Then click on the Inflate/Deflate toggle button to alternately inflate and deflate the actual corresponding balloons on the CPL to see if they are functioning properly.

3. If the *Check Balloons* procedure demonstrates that a balloon is not being inflated or is not maintaining its inflation pressure, the balloon valve sleeve can be changed using a kit available from Collins Medical, Inc. Customer Service department (800-635-3200) that contains replacement balloon sleeves and o-rings. Refer to the CPL Manual for more details. When a sleeve is replaced, it must be put through a Balloon Conditioning procedure to ensure the balloon inflates to full size and properly occludes the valve path it controls.

## Conditioning the Balloons

1. Click the *Condition Balloons* tab to activate this procedure. The steps for performing the Condition Balloons procedure are displayed in the *Notes* frame to the left of the valve image. The *Options* frame contains three text boxes containing the default parameters for this process. While the parameters can be changed, there is rarely a need to do so. Collins recommends that you perform the conditioning process using the default parameters.

2. With the Inflation *Cycle Time* set to its default value of 5, the selected balloons will be inflated for five seconds and deflated for five seconds. The *Cycles Remaining*: text box parameter (default value is 100 cycles) will be decreased at the conclusion of each inflation/deflation cycle. When the *Cycles Remaining*: count reaches zero, the balloons will be inflated and held for the *Inflation Hold Time*: which is 600 seconds by default. Once started, this procedure will run unattended. The process may be interrupted at any time by clicking on the *Stop* button.

3. You may wish to purchase additional balloon valve cores through Collins Medical, Inc. and condition a set of balloons during a slack period so that it is not necessary to interrupt patient testing to condition a balloon.

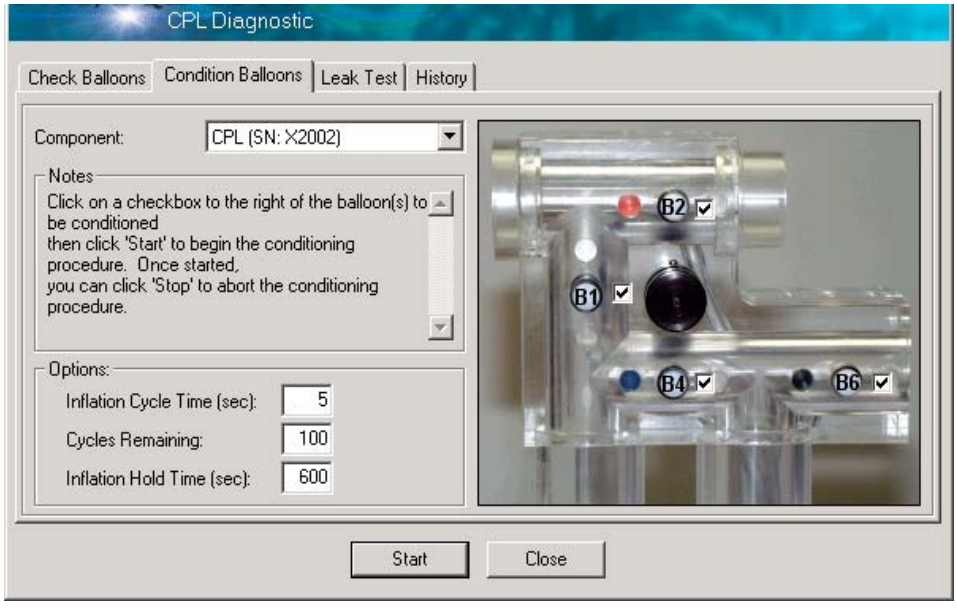



Figure 9-3. Conditioning the Balloons

## Conducting a Leak Test

1. To check for leaks in the CPL pneumatic circuitry, click on the *Leak Test* tab.

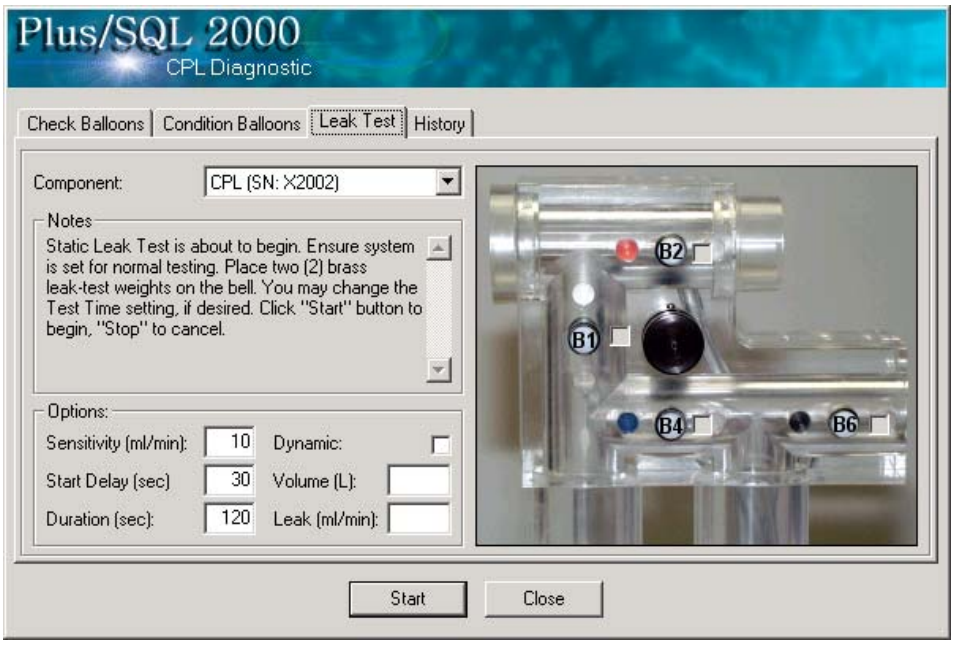



Figure 9-4. Leak Test Opening Screen

2. You may check for static (without the motor blower running) and dynamic (with the motor blower running) leaks in the circuitry. If a static leak exists, the spirometer bell will always fall as volume is lost. With the dynamic leak test, if a leak exists on the exhaust side of the blower, the bell will fall due to loss of volume, just as for a static leak. However, if a leak exists on the intake, or suction, side of the blower, the bell will rise as volume is added to it.

3. The leak test instructions are given in the *Notes* frame to the left of the valve image. The valve checkboxes will be inactive (grayed-out) in this mode and you will not be permitted to select balloons to inflate, as the leak test program controls balloon inflation.

4.To conduct a static leak test, leave the *Dynamic* box unchecked. To Conduct a Dynamic leak test, click on the *Dynamic* box.

5. Set up the system as instructed on the screen.

6. The *Options* frame contains several text boxes in addition to the *Dynamic* checkbox:

   The *Sensitivity* (ml/min) text box indicates the volume change per minute, which if exceeded, will be reported as a leak. The user can enter any number, but the default value of 10 ml/min is the ATS recommended maximum leak rate per minute (with 3.0 $cmH_2O$ of pressure on the spirometer bell).

   The *Start Delay (sec)* is the number of seconds of delay that must elapse before the leak test program will record a starting volume reading. This allows time for the system to stabilize and the bell to settle before measurement of bell movement begins. This eliminates false positive leak test results.

   The *Duration (sec)* determines the amount of time that must elapse before the program calculates the change in spirometer position. While this number can be changed by the user, the default value of 120 sec. (2 minutes) has been selected to minimize false positive leak test indications resulting from technical factors within the system. (Minimum volume resolution of analog-to-digital (A/D) converter in the system.)

   The *Volume (L)* text box displays the real-time volume in the spirometer. The *Leak (ml/min)* displays the leak rate dynamically.

7. For either phase of the leak test, press *Start*. After the indicated delay, the program will display *The leak test has started*.

8. During the leak test, real-time information regarding the status of the system (time, spirometer volume, dynamic leak rate)

will be displayed in the *Notes* frame, as a separate line of data updated at the end of each sampling period. The spirometer volume and the rate of the leak, if any, will be displayed in the designated boxes. The test will stop after the indicated duration, at which point the program will display the results of the leak test.

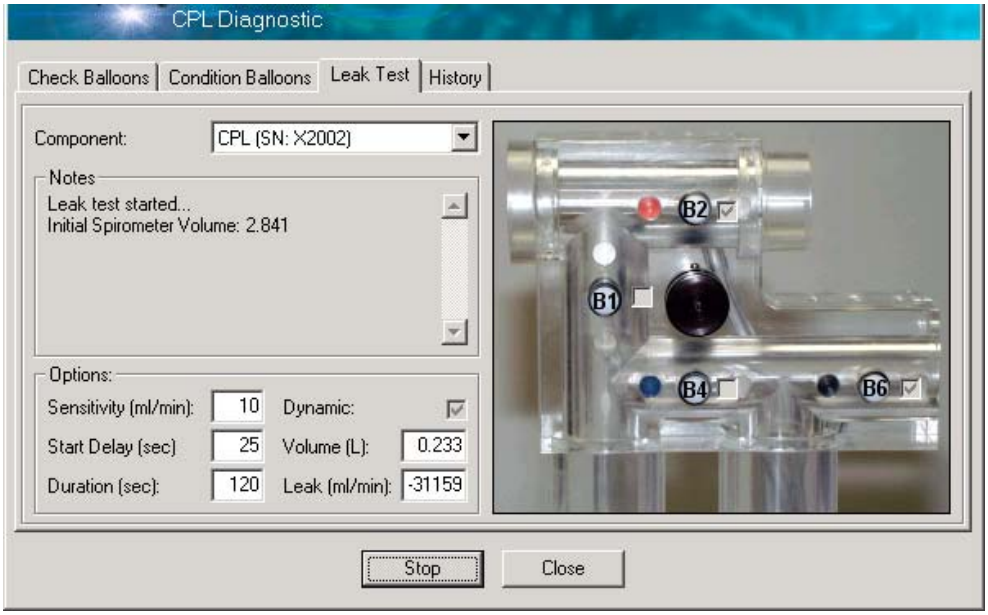



Figure 9-5. Conducting a Leak Test

9. If a leak is indicated, refer to the Troubleshooting section of your CPL hardware manual for instructions on eliminating portions of the pneumatic circuitry in order to find the leak.

## Obtaining a Diagnostic History

1. Clicking on the *History* tab displays a record of all testing activity performed using the CPL Diagnostic program, including the time of each test performed and a record of any information messages that were displayed, such as discussed for the leak test.

2. The contents of the *History* tab may be printed by right-clicking on the history window, and clicking on *Select All*. All text within the window will be selected (highlighted). Right-clicking on the history window again and clicking on *Copy* will copy the contents of the history window to the clipboard, from which it can be pasted into Notepad or any text editor or word processor program. History data may be edited as desired from within these programs.

3. Clicking the *Clear* button will erase the contents of the history window. If the history window is not cleared, the history data remains stored in a file and any additional history collected during testing will be appended to the end of the history file. Clicking the *Close* button terminates the CPL Diagnostic program.

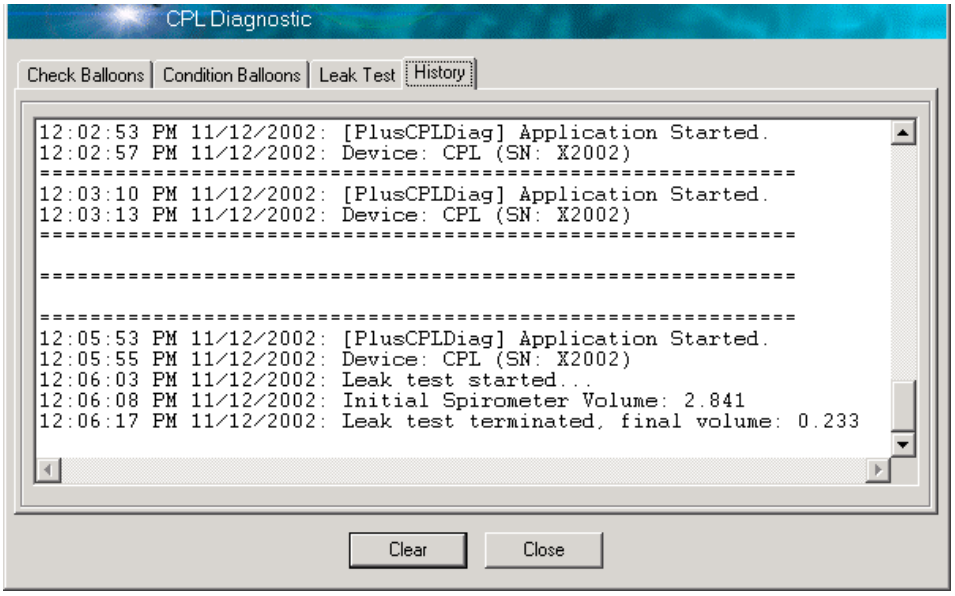

CPL Diagnostic
Check Balloons
Condition Balloons
Leak Test
History
12:02:53 PM 11/12/2002: [PlusCPLDiag] Application Started.
12:02:57 PM 11/12/2002: Device: CPL (SN: X2002)
12:03:10 PM 11/12/2002: [PlusCPLDiag] Application Started.
12:03:13 PM 11/12/2002: Device: CPL (SN: X2002)
12:05:53 PM 11/12/2002: [PlusCPLDiag] Application Started.
12:05:55 PM 11/12/2002: Device: CPL (SN: X2002)
12:06:03 PM 11/12/2002: Leak test started...
12:06:08 PM 11/12/2002: Initial Spirometer Volume: 2.841
12:06:17 PM 11/12/2002: Leak test terminated, final volume: 0.233
Clear
Close

Figure 9-6. The Diagnostic History Tab

# SECTION TEN -- THE PLUS/SQL 2000 PREDICTED EDITOR

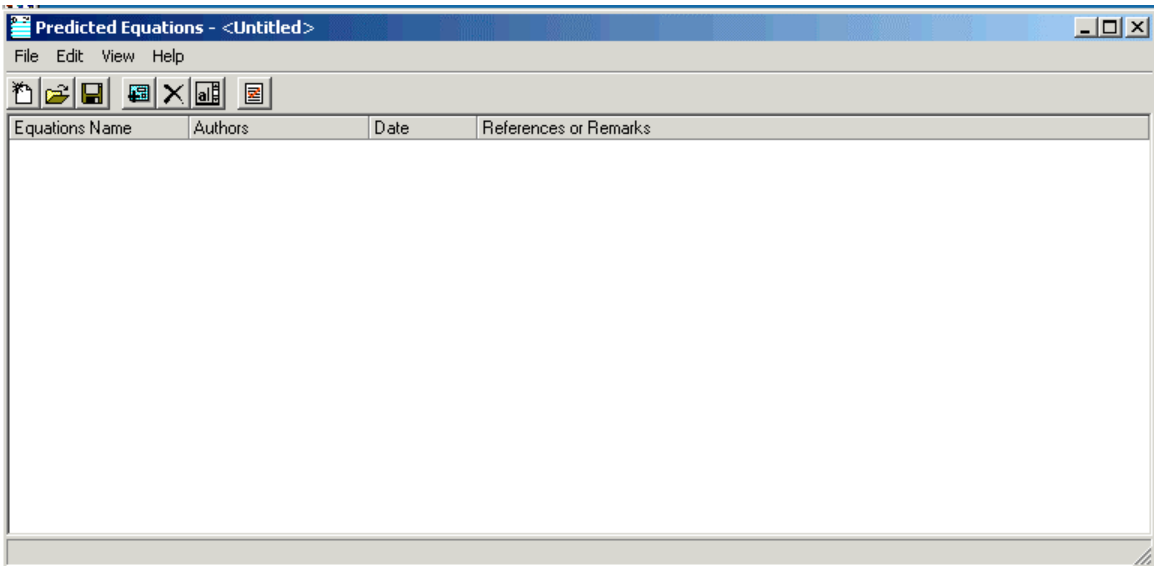



Figure 10-1. Opening Screen of the Predicted Equations Editor

The Predicted Editor runs as a stand-alone utility. The editor creates .xml files containing predicted equation authors, their equations, and supporting information needed to calculate the appropriate predicted equations for a given gender and age category. The editor may also be used to open an existing .xml file of predicted equation data, edit the data, and resave it. *It is important to note that the editor works only with .xml files; it knows nothing of the predicted author/equation data in a PLUS/2000 database and the predicted equations in a PLUS/2000 installation are never read or manipulated by the editor.*

The PLUS/2000 program (beginning with PLUS/2000 v4.03) makes provisions for updating the predicted equation data in a database by loading the contents of a predicted data .xml file into the database.

## Starting the Predicted Editor:

Depending on how the Predicted Editor was installed, it may be started by clicking Start\Program Files\PLUS/2000\Predicted Editor, or from Explore by double-clicking on the file name PlusPredEdit.exe normally found in C:\Program Files\Collins Medical\PLUS/2000, or by double-clicking on a desktop shortcut icon if one is present. Upon starting, the editor will display the main Predicted Equation - <Untitled> window shown above. The main screen follows standard Windows® conventions: a title bar that displays the program name and the currently loaded predicted equation file, a standard Windows® menu, and a button bar with icons for options to (left to right) (1) create a new file, (2) open an existing file, (3) save the currently loaded file, (4) add a new equation or protocol depending on the currently selected option in the View menu option, (5) delete the currently selected item, (6) edit the currently selected item, and (7) activate the equation Test function dialog.

## Menu Options:

The menu provides the expected standard Windows® functionality needed by the Predicted Editor.

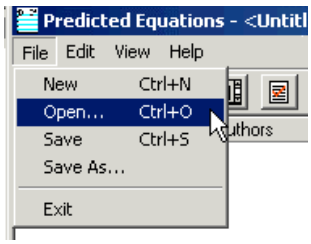



Figure 10-2. The Predicted Equations File Menu

The File menu New option creates a new file. The Open Option displays the standard Windows® file Open dialog to permit viewing or editing of an existing predicted data .xml file. The Save and Save As… options display the standard Windows® Save or Save As… . The editor always saves files as an .xml file.

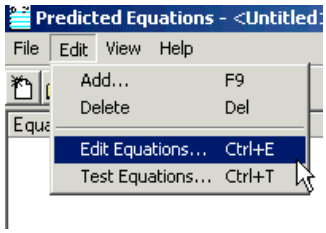



Figure 10-3. The Predicted Equations Edit Menu

The Edit menu item provides options to add or delete equations or protocols according to the currently checked selection in the View menu (see discussion of View options below.) Edit Equations… will display the equation or protocol editor dialog window according to the currently selected View option. Test Equations… will display the Test dialog, which allows a user to select equations, enter gender, age, height, and weight demographic information and then calculate and display the results for the currently selected equation based on that data. This is very handy for checking the validity of entered equations.

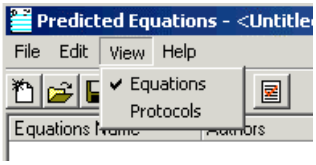



Figure 10-4. The Predicted Equations View Menu

The Predicted Editor provides for two editing modes: equation editing and protocol editing. The currently checked mode will determine the action of various menu selections and buttons as described above.

### Opening a predicted data .xml file:

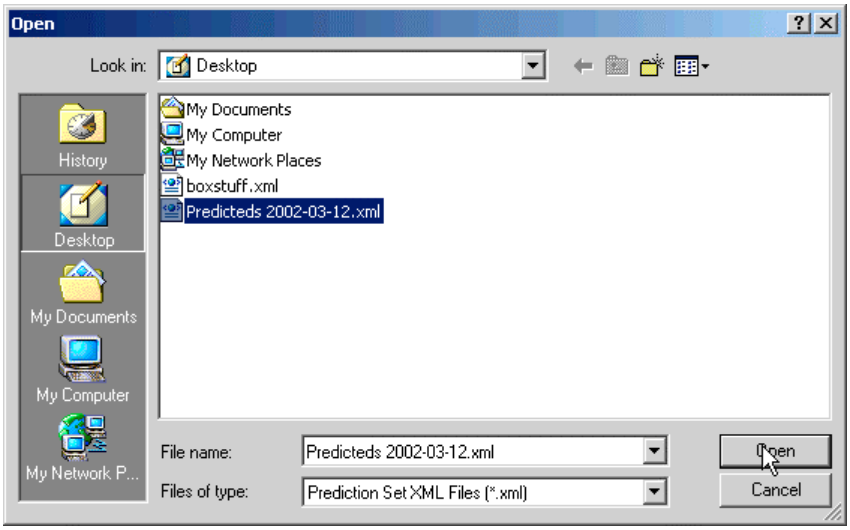



Figure 10-5. Opening a Predicted Data .xml File

Clicking the Open… selection on the Files menu dropdown or clicking on the open files icon on the button bar located beneath the menu bar will display a standard Windows® Open dialog with the default Files of Type: value set for *.xml files. Double-clicking on an .xml file in the file list will open that file in the editor

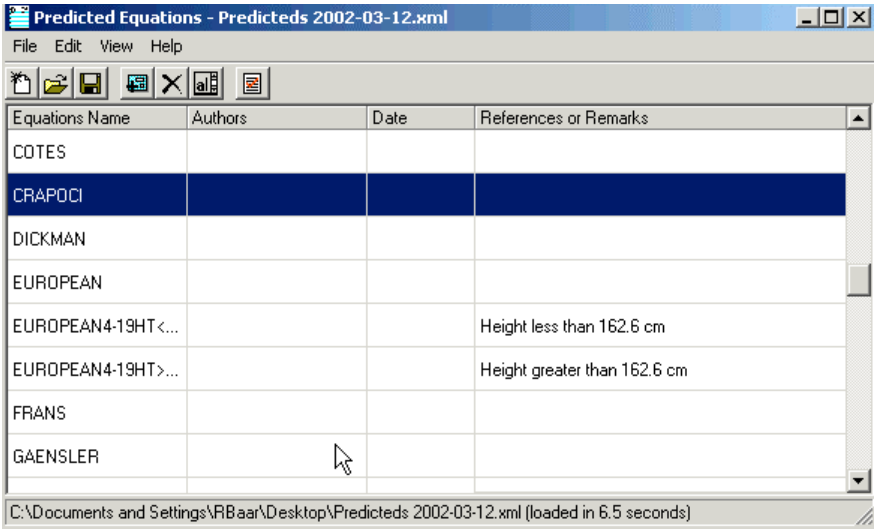



Figure 10-6. An Open Predicted Data .xml File

When a predicted data .xml file is opened, the file data will be displayed in the mode currently checked option in the View menu dropdown. For this example, the Equations option was checked so the .xml file is opened displaying a list of equation names, authors, date, and References of Remarks. Double-clicking on an equation name will select that equation and display it in the Equation Editor. The user can scroll up and down through the list to find the desired equation name or, as a short-cut, single-click anyplace in the Equation Name column and type the first one or two characters of the desired equation name and the list will be immediately positioned to that section of the alphabet. Clicking on the header of any column will sort and display the entries in that column in ascending order, clicking a second time resort and display the entries in descending order. Continued clicking toggles back and forth between the two sort orders. In this example, double-clicking on CRAPOCI will bring up the Equation editor displaying data for CRAPOCI equations

**The Equation Editor:**

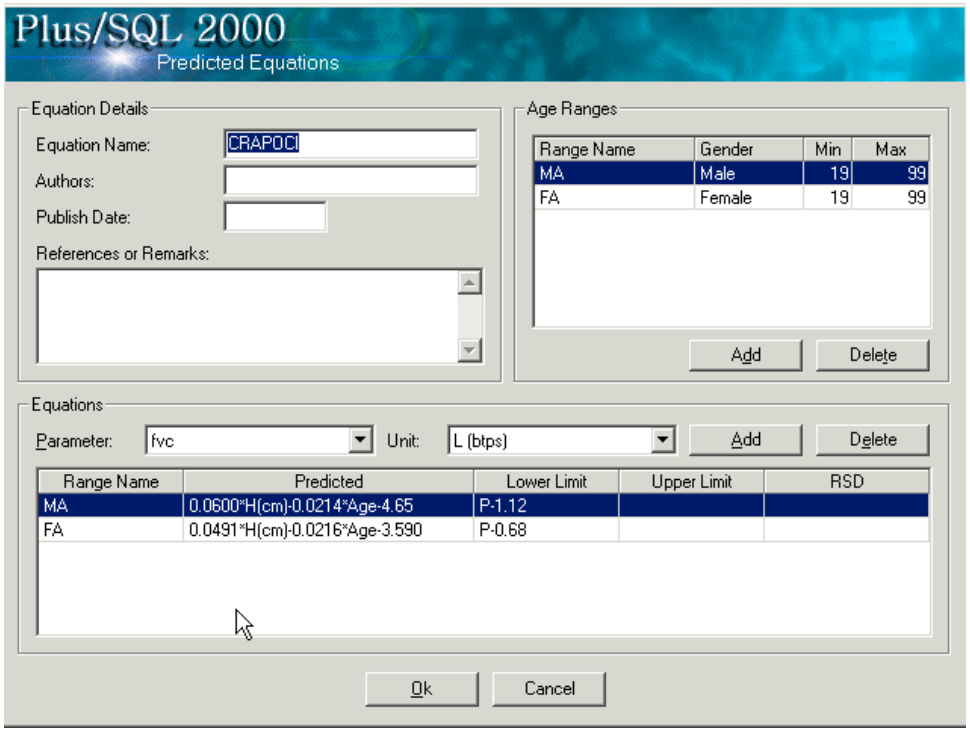



Figure 10-7. The Predicted Equation Editor

The Equation editor is divided into three frames:

The left frame, labeled Equation Details, displays the equation name for the selected equation. Text fields are provided for Author information, the publish date of the equation, and a text box which can be used to enter information related to equation such as the journal citation or miscellaneous remarks. Only the Equation Name field is used during searches. The other fields in the frame are informational only and are not searched. (NOTE: all searches in the Predicted Editor are case insensitive so entries can be in any combination of upper and lower case.)

The right frame, labeled Age Ranges, displays gender and the defined age ranges that have been defined for the Equation Name. The left field, Range Name, is descriptive of the age-gender range only and is not used in searches. Any descriptive information for a gender-age range can be entered here (maximum 32 characters.) Equation searches are based on the criteria defined by the equation name, the gender, and age range bracketed by, and including, the minimum and maximum ages displayed.

**NOTE:** the minimum and maximum ages displayed here are intended to reflect the age range defined by the author publishing the equations. They are intended as a reference so a user creating a protocol of predicted equations can be aware of the valid age range for an equation as stipulated by the equation author. It will be seen later, in the discussion on creating protocols that, in defining a protocol the user may elect to extend the age range for a variety of reasons such as extending the protocol age range to include elderly subjects who are somewhat older than the oldest subject within the pool of subjects tested when collecting data to determine the regression equations for a parameter. Thus the two age ranges need not be identical.

The Age Ranges frame provides an Add button to enable a user to define additional age ranges, and a Delete button, which will delete the currently selected and highlighted age range. In entering Gender data into a range, the user may type F, M, or B (for Female, Male, or Both), or may click on the down-arrow that will appear to the right of the Gender field when clicked and select the desired gender from the list. To move to the next field, press the <Enter> key, right or left arrow key, or click in another box. Clicking on the label heading for any column will alternately sort the entries in that column by ascending and descending order.

The lower frame, labeled Equations, contains a dropdown text box containing a list of available parameters, a units text box, which displays available units appropriate to the selected parameter, and a display grid that displays the Range Name selected in the Age Ranges frame, the predicted equation, lower and upper limits, and the Residual Standard Deviation (RSD). All available equations for the currently displayed Equation Name are displayed, and the gender-age range highlighted in the Age Ranges frame is highlighted in the equations grid.

Clicking on the column header label will alternately sort the entries in that column in ascending or descending order.

To enter or edit an equation, a lower or upper limit, or an RSD, click on the field and then click the button that displays to the right of the field, or double-click a field; the Equation Script Editor will be displayed. Constants or equations can be entered into the script editor. Clicking OK on the script editor window closes the script editor and updates the contents of the field being edited with the contents of the script editor.

The Equations frame provides an Add button to add a predicted equation, limits data, and RSD values for the Range Name selected and highlighted in the Age Ranges frame. Each Range name can be associated with only one set of predicted equation, limits, and RSD data. Attempts to enter equation, limit, and RSD data for a Range Name already defined will result in an error condition.

**Entering equations, constants, ranges, and RSD data in the Equation Script Editor:**

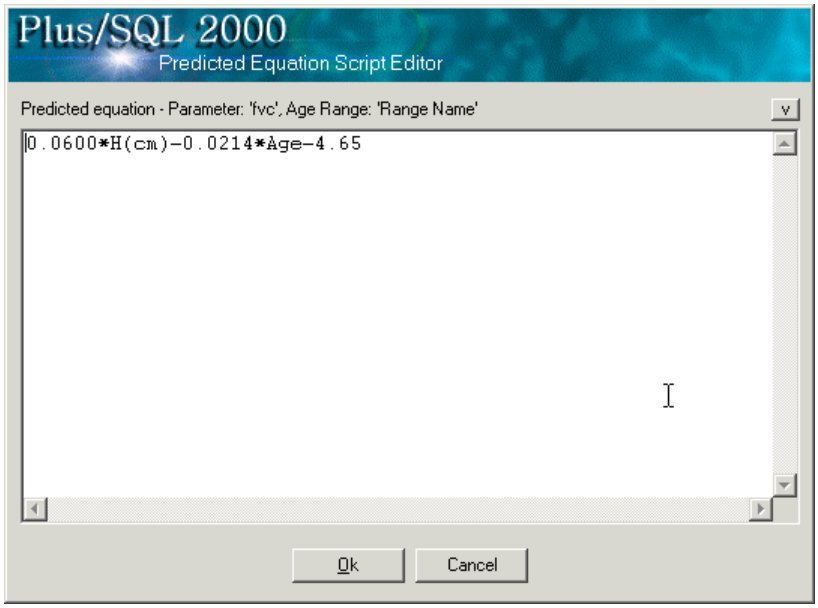



Figure 10-8. The Predicted Equation Script Editor

The Equation Script Editor provides the user with the full functionality of the Microsoft Visual Basic Scripting (VBS) language* in entering equations for Predicts, limits, and the RSD. Constants and/or equations can be entered directly, or a VB function can be created, which will permit the user to embed logical testing for the selection of the appropriate equation based on a variety of conditions. (The use of functions to embed logical testing into equation selection will be discussed in a separate section.)

When entering a lower or upper limit, the variable 'P' (for Predicted value) is used to indicate the calculated value of the predicted equation in the Predicted column, thus, as an example for a lower limit, P – 0.5 would be resolved by subtracting 0.5 from the calculated predicted equation for that Range Name and parameter. Likewise, an upper limit that is 0.5 above the calculated predicted value would be entered as P + 0.5. Any valid parameter name can also be used as a variable. For example, to set the lower limit to 80% of the predicted MVV for the currently selected MVV equation, enter the lower limit as (mvv - (mvv * 0.80)) or (P – (P * 0.80)).

The Residual Standard Deviation (RSD) can be a constant value or any equation that will resolve to a constant value.

In addition to the variables discussed above, the Predicted Equation Editor recognizes the following variables for use in entering predicted equations:

Height = H(units) where allowable units are inches, cm, or m (for meters).
Age = Age years is assumed and must be entered as an integer value (i.e. no fractions of a year are permitted.)
Weight = W(units) where allowable units are lbs, kg
Body Surface Area = BSA $BSA = W(kg)^{0.425} * H(cm)^{0.725} * 0.007184$

(From: DuBois, D. and DuBois, E.F. *Clinical Calorimetry. A formula to estimate the approximate surface area of if height and weight be known.* Arch. Int. Med., 17:863, 1916)

* See Addendum A for Microsoft Visual Basic Script (VBS) programming information sources.

## The Predicted Equation Protocol Editor:

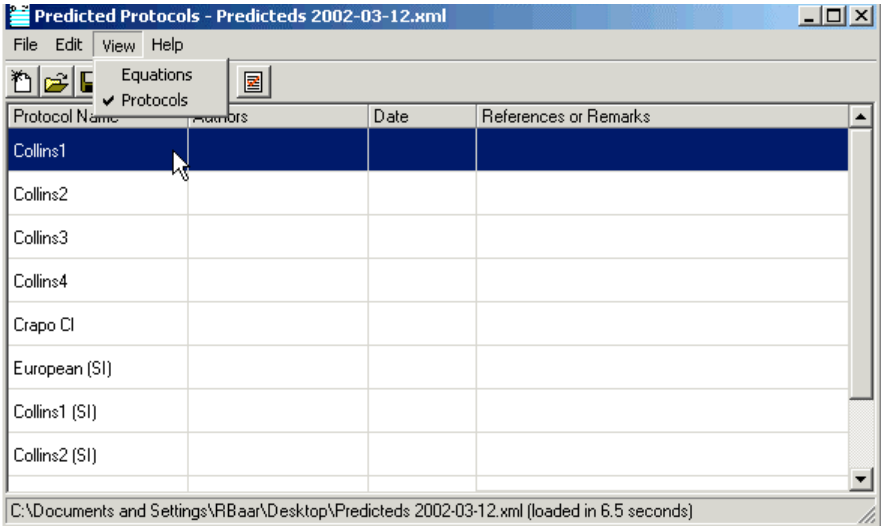



Figure 10-9. Accessing the Predicted Equation Protocol Editor

When the Predicted Editor is set to the Protocol mode by checking the Protocol selection in the View dropdown box, the main editor screen displays a listing of available protocols. Double-clicking a protocol name will bring up that protocol in the Protocol Editor dialog window.

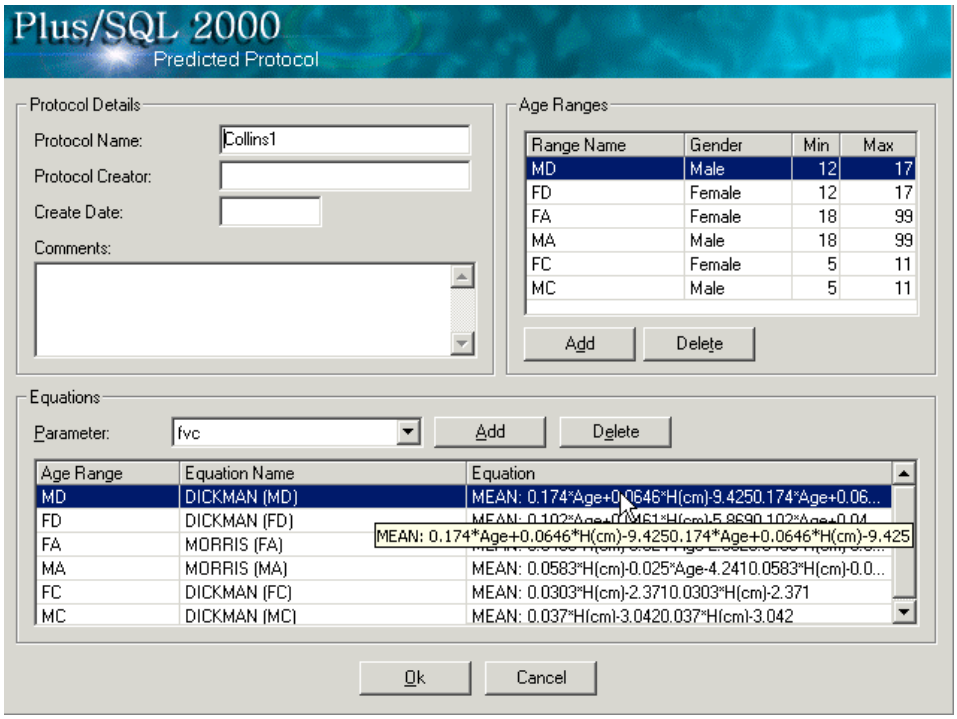



Figure 10-10. The Predicted Equation Protocol Editor

The Protocol Editor is divided into three frames:

The left frame, labeled Protocol Details, displays the protocol name for the selected protocol. Text fields are provided for protocol name, the protocol creator, a create date, and a text box labeled Comments which can be used to enter information or miscellaneous remarks related to the protocol. Only the Protocol Name field in this frame is used during searches. The other

fields in the frame are informational only and are not searched. (NOTE: all searches performed by the Predicted Editor are case insensitive so entries can be in any combination of upper and lower case.)

The right frame, labeled Age Ranges, displays gender and the defined age ranges that have been defined for the Equation Name. The left field, Range Name, is descriptive of the age-gender range only and is not used in searches. Any descriptive information for a gender-age range can be entered here (maximum 32 characters.) Searches are based on the criteria defined by the protocol name, the gender, and age range bracketed by, and including, the minimum and maximum ages displayed.

**NOTE:** the minimum and maximum ages displayed here are intended to reflect the age range defined by the author publishing the equations. They are intended as a reference so a user creating a protocol of predicted equations can be aware of the valid age range for an equation as stipulated by the equation author. It will be seen later, in the discussion on creating protocols that, in defining a protocol the user may elect to extend the age range for a variety of reasons such as extending the protocol age range to include elderly subjects who are somewhat older than the oldest subject within the pool of subjects tested when collecting data to determine the regression equations for a parameter. Thus the two age ranges need not be identical.

The Age Ranges frame provides and Add button to enable a user to define additional age ranges, and a Delete button, which will delete the currently selected and highlighted age range. In entering Gender data into a range, the user may type F, M, or B (for Female, Male, or Both), or may click on the down-arrow that will appear to the right of the Gender field when clicked and select the desired gender from the list. To move to the next field, press the <Enter> key, right or left arrow key, or click in another box. Clicking on the label heading for any column will alternately sort the entries in that column by ascending and descending order.

The lower frame, labeled Equations, contains a dropdown text box containing a list of available parameters, a units text box, which displays available units appropriate to the selected parameter, and a display grid that displays the Range Name selected in the Age Ranges frame, the predicted equation name, and the equation itself. The fields in this pane are fixed, but if the length of an equation is too long to fit in the equation field, placing the pointer on that field will pop up a tool-tip showing the entire equation. All equations for all designated gender-age ranges, for the currently displayed parameter, are displayed, and the corresponding gender-age range is highlighted in both the Age Ranges frame and in the equations grid.

As is standard throughout the Predicted Editor, clicking on a column header label will alternately sort the entries in that column in ascending or descending order.

To change an equation for an age range, double-click in the Equation Name or Equation field in that grid row and the Predicted Protocol Equation Selector dialog window will be displayed.

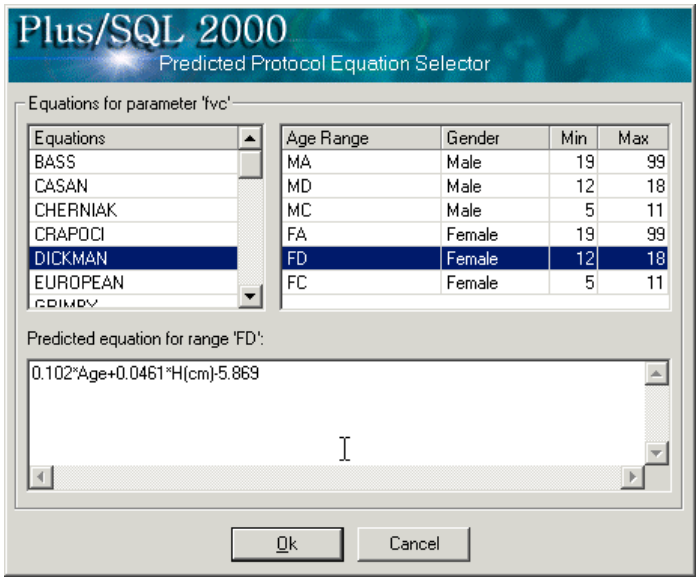



Figure 10-11. The Predicted Protocol Equation Selector

The Protocol Equation Selector contains one frame labeled Equations for parameter 'xxx' (where 'xxx' is the currently selected parameter.) Within this frame are three panes. The upper left *Equations* pane displays a list of the available equation names for the currently selected parameter, the upper right pane displays the gender-age range information defined for the currently selected protocol, and the lower *Predicted equation for range 'xx'* (where 'xx' is the currently selected age range in the upper right pane) displays the equation for the currently selected equation name.

Selecting an Age Range and an equation name and clicking OK will update the equation name for the currently selected Age Range in the Protocol Editor dialog.

Only one equation name is allowed per parameter for each Age Range. Attempts to Add an equation name to an already defined Age Range will result in an error.

**Age Ranges in Protocols:**
It is important to understand how age ranges are handled with regard to predicted equations. In the screen shot below note that the age range for the Dickman equation for male adolescents displayed in the Protocol Editor screen is 12 through 17 years, while in the Predicted Protocol Equation Selector, the same age range is 12 through 18. In general, the age range listed for an equation in the Protocol Editor is the range cited in the reference for the equation, i.e. the actual published age range of the population used to establish the regression equation. This approach enables a user that may not have access to the actual paper in which the predicted equations were published to be aware of the valid age range for a given gender-age category. However, this age range is independent of the age range selected for a given protocol, allowing an end-user to create a protocol in which a given age-range differs from that of the predicted study population. The most common reason for extending an age range would be that in the published population, the oldest subject was 70 years old, but a given lab might choose to extend that equation to patients older than 70 because another regression equation for patients older than 70 cannot be found. Extending the age range for a gender-age category above or below the equation author's published range should be done only at the pulmonologist's discretion.

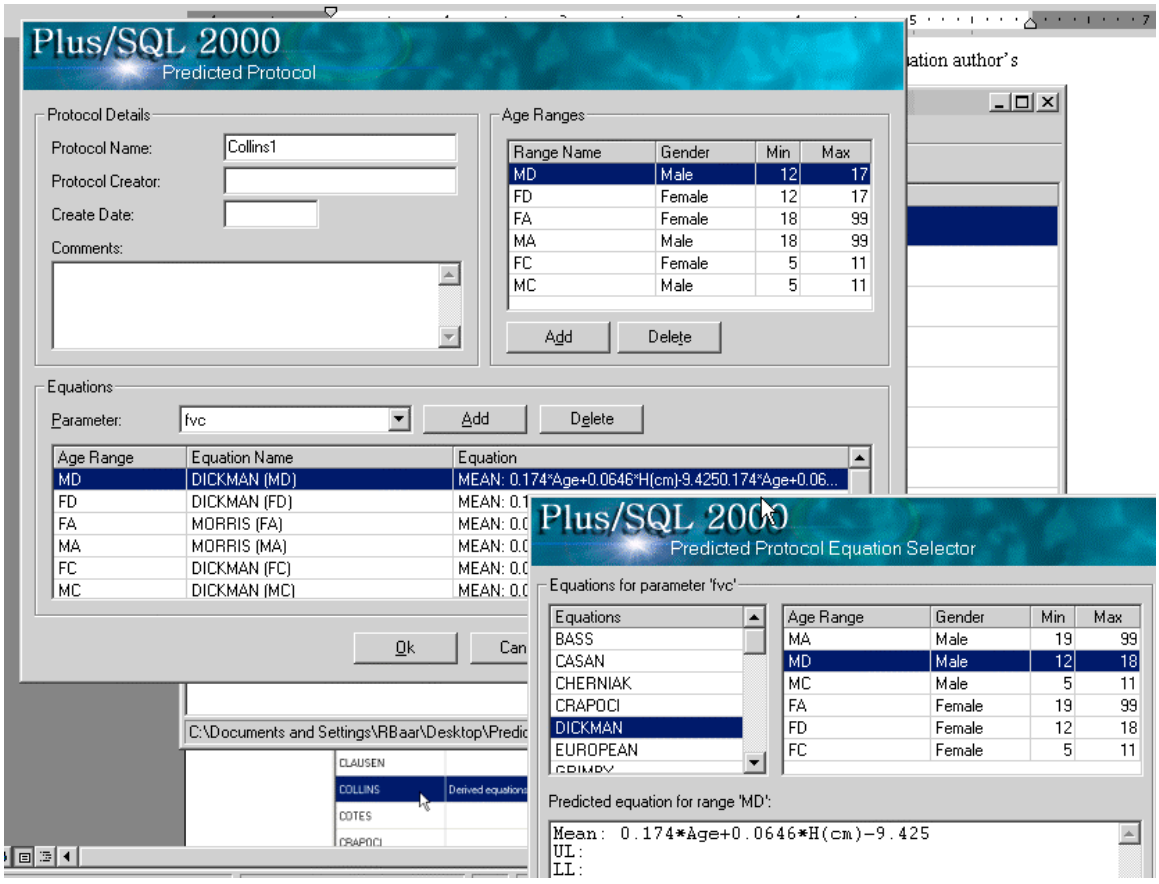



Figure 10-12. Age Ranges in Predicted Protocols

Note in the screen shot above that, while only the age range, equation name, and the equation are displayed in the Predicted Protocol Editor, the Equation Selector dialog displays the complete equation mean and any upper and lower limits entered for that equation.

**Derived Equations:**

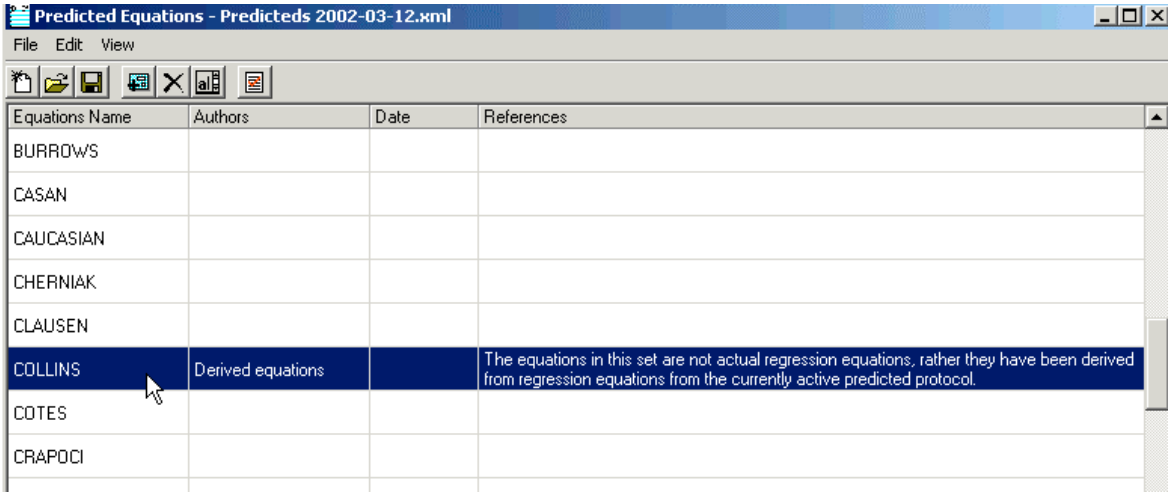



Figure 10-13. Reference to the *Collins* Protocol as Consisting of Derived Equations

In addition to calculating the predicted mean according to a regression equation, the Predicted Editor and the predicted calculation engine can also perform calculations based on, what we call here for lack of a better term, 'derived' equations. A derived equation is an equation that is composed of previously calculated predicted mean values. For example the predicted value for the FEV1/FVC may be calculated by dividing the previously calculated predicted mean for the FEV1 by the previously calculated predicted mean for the FVC. **The equations used by the derived equation must exist in the current protocol for both parameters.* (See next paragraph.) This ability simply provides a shortcut to creating a long equation composed of the equations for the FEV1 and FVC.

*There is a caveat to be aware of when entering a derived equation. The parameters used in a derived equation must have been defined prior to their use in the derived equation. If an undefined parameter is used in the derived equation, the equation field will display the message, 'Undefined Variable in Equation.' The parameters exist in the database in the same order as they are listed in the parameter dropdown list. If a parameter used in a derived equation has not been previously defined, an error message "Undefined variable <xxx>" where xxx is the undefined variable, will appear in the equation field. If the equation in the equation field is truncated, place the mouse pointer over that field; a tool tip displacing the complete equation message will pop up.

By convention, in PLUS/2000, all derived equations are contained in a single protocol named COLLINS.

Example:

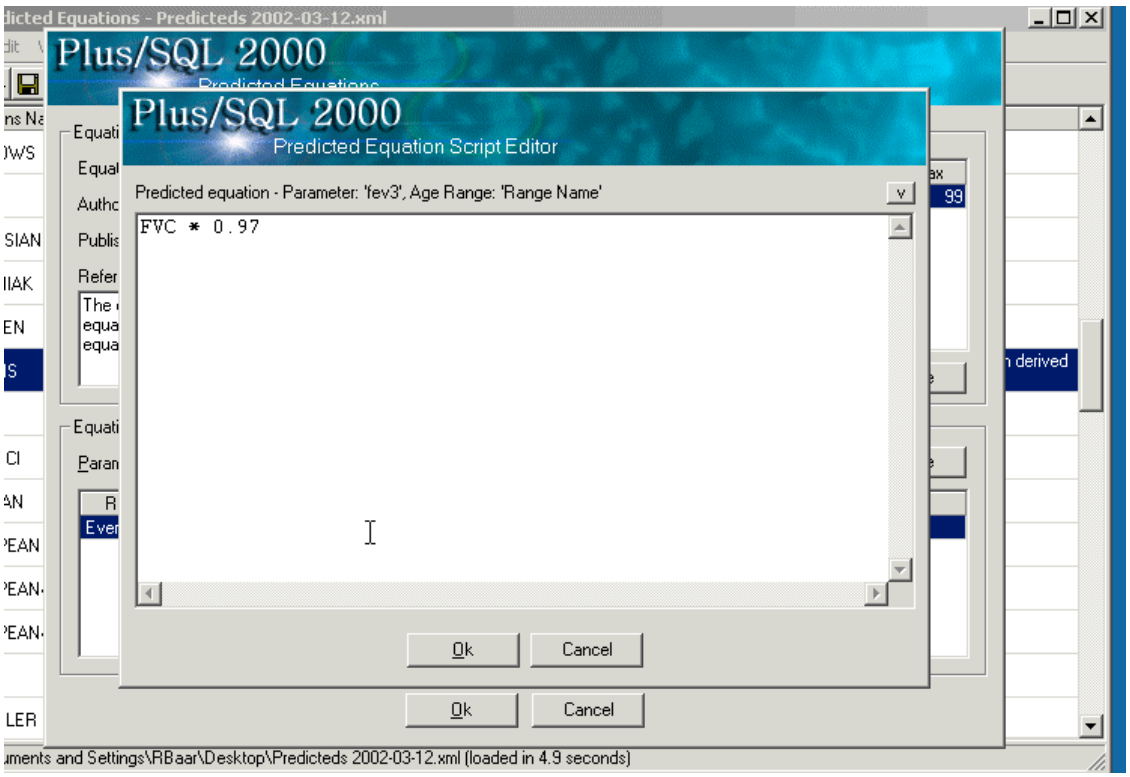



Figure 10-14. Example of a Derived Equation in the Script Editor

In the screen shot above, the FEV3 predicted has been defined as a derived equation based on the previously calculated FVC value. It is simply, FEV3 = 97% of the FVC.

The final derived FEV3 equation saved in the predicted equation .xml file is displayed in the equation field of the screen shot below as FVC * 0.97.

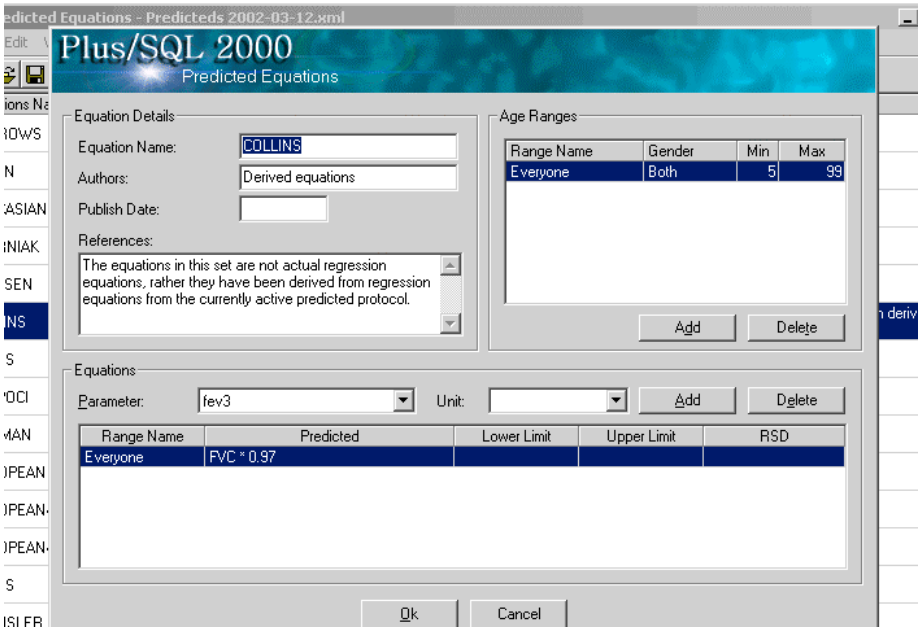



Figure 10-15. Final Derived Equation Saved in the .xml file

**The Use of Functions in Predicted Equations:**

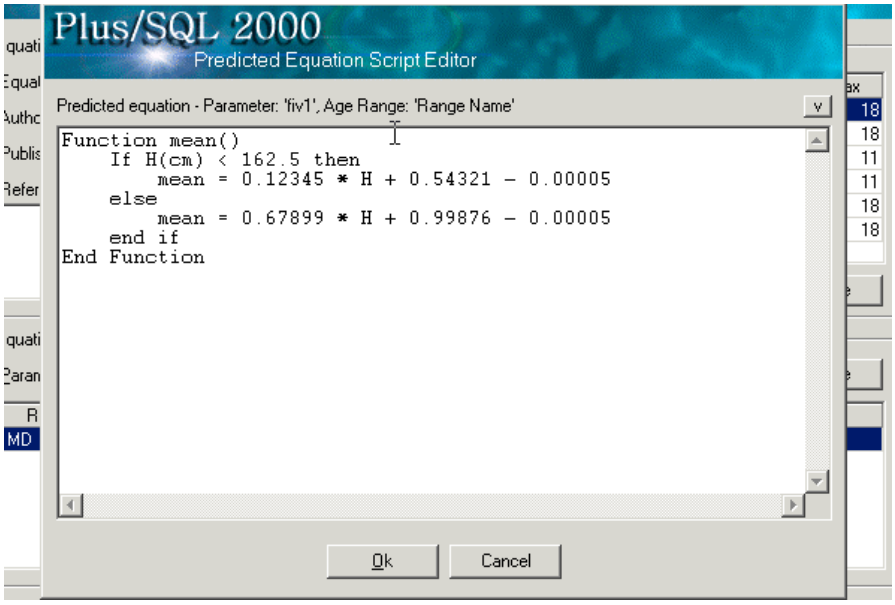



Figure 10-16. The Use of Functions in Predicted Equations

There may be times in calculating a set of mean predicted values for a patient that a decision is required to determine which, of two or more equations, is the correct equation for the current patient. As an example, consider the situation in which the selection of the proper predicted equation for a patient less than 19 years of age takes consideration of the height. Say, if the youngster's height is less than 162.5 cm, equation A is used: if the height is greater than 162.5 cm, equation B is used. (This situation occurs in some of the predicted equations recommended by the European Respiratory Society (ERS). The PLUS/2000 Predicted Editor is designed to accommodate this situation.

With the desired parameter selected in the parameter list of the Predicted Equation Editor, double-click on the equation field to display the Equation Script Editor. Click the button with the down-arrow located above the top of the scroll bar. The Script Editor displays a VBS function template for the selected parameter. Enter the necessary code to test for the various conditions (in this case patient height) and enter the proper equations for each condition following the syntax of Microsoft VBS.

Once the code is correctly entered, clicking the OK button on the Equation Script Editor will close the editor dialog. The Predicted field in the Predicted Equation Editor dialog will indicate 'Function mean()' which is a general function name for all functions. The editor and predicted calculation engine can keep all functions sorted out as each is tied to its specific parameter. When the predicted equation calculation engine calculates the mean predicted values for a protocol, it will check the value of the appropriate parameter (height here) to determine which equation to use in calculating the current patient's predicted mean for that parameter.

A function can test on any valid predicted equation variable. (The list of possible variable was given earlier in this document.) See Addendum A for sources of information on the use of Microsoft Visual Basic Scripting language (VBS).

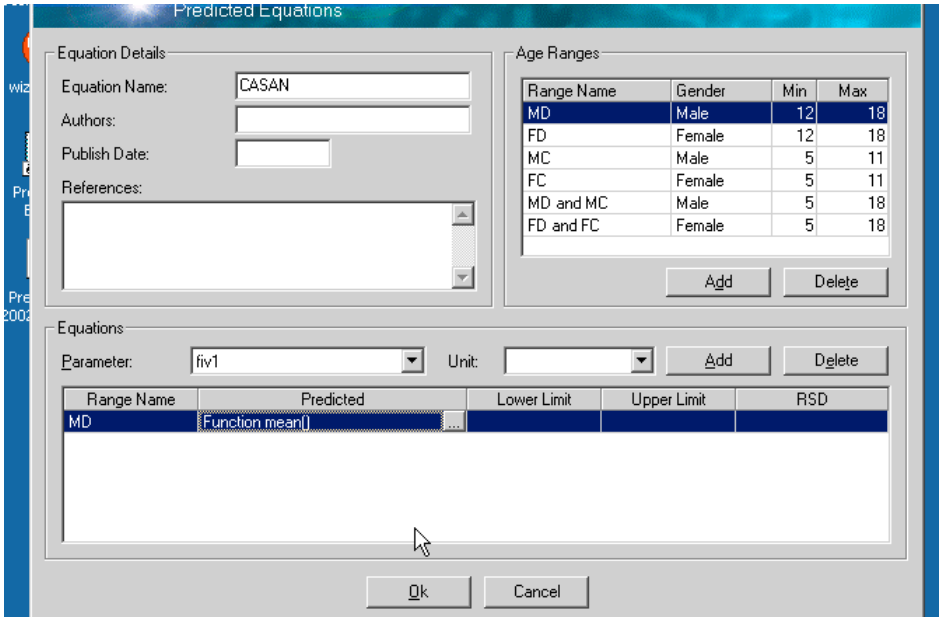



Figure 10-17. Function Mean() Displayed in the *Predicted* Field of the Equation Editor

## Testing Equations:

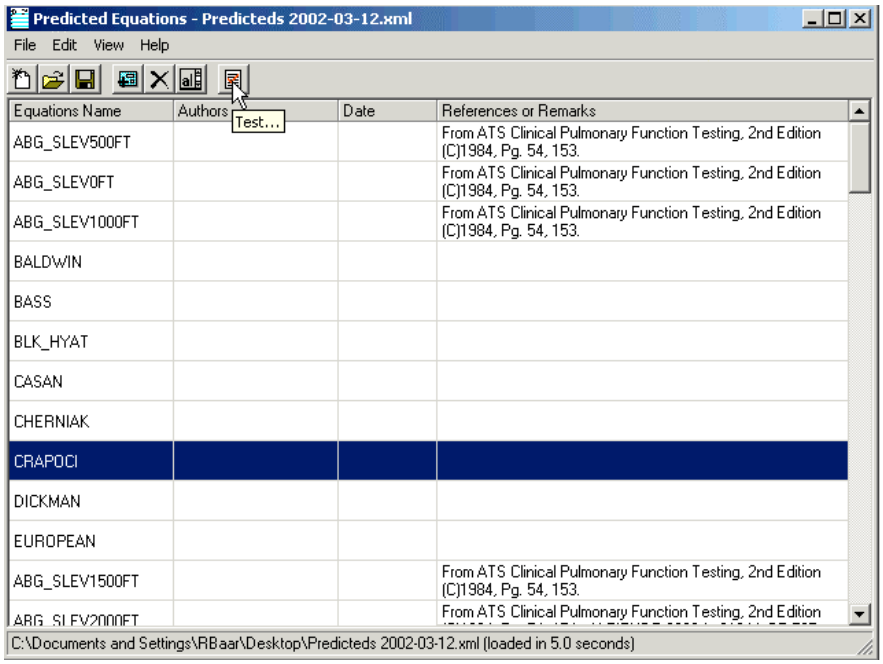



Figure 10-18. Pressing the *Test* Button for the Selected Equation

The Predicted Equation Editor provides a test function to enable the testing of entered equations. Begin by selecting the Equation mode in the View menu option. Then click to select the equation you wish to test and click on the Test… button at the right of the button bar on the main screen.

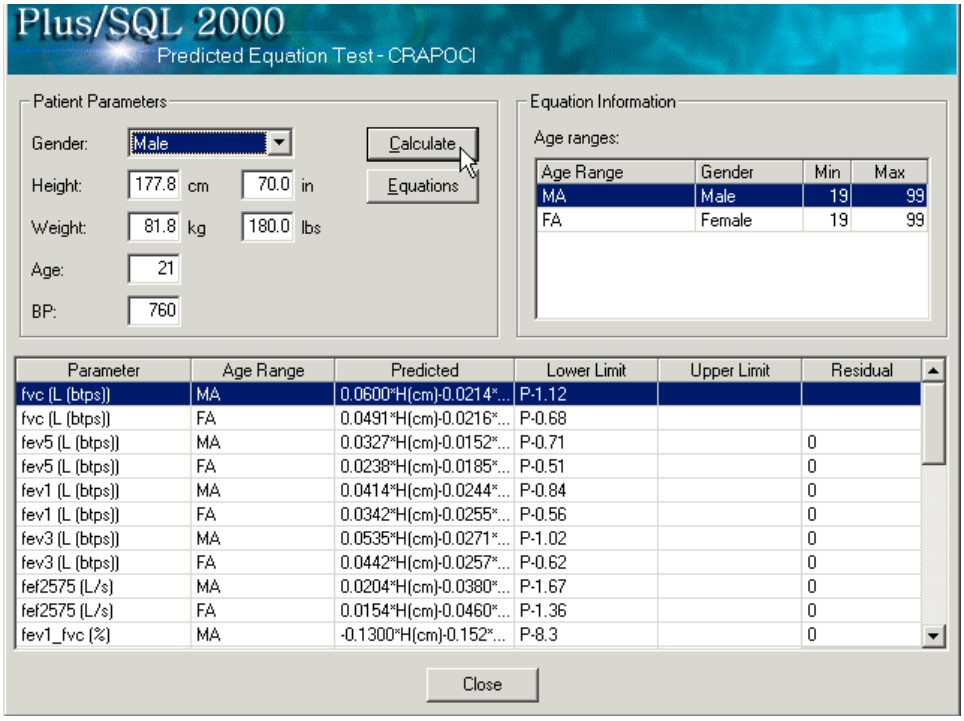

Plus/SQL 2000
Predicted Equation Test - CRAPOCI
Patient Parameters
Gender: Male
Height: 177.8 cm 70.0 in
Weight: 81.8 kg 180.0 lbs
Age: 21
BP: 760
Calculate
Equations
Equation Information
Age ranges:
Age Range Gender Min Max
MA Male 19 99
FA Female 19 99
Parameter Age Range Predicted Lower Limit Upper Limit Residual
fvc (L (btps)) MA 0.0600*H(cm)-0.0214*... P-1.12
fvc (L (btps)) FA 0.0491*H(cm)-0.0216*... P-0.68
fev5 (L (btps)) MA 0.0327*H(cm)-0.0152*... P-0.71 0
fev5 (L (btps)) FA 0.0238*H(cm)-0.0185*... P-0.51 0
fev1 (L (btps)) MA 0.0414*H(cm)-0.0244*... P-0.84 0
fev1 (L (btps)) FA 0.0342*H(cm)-0.0255*... P-0.56 0
fev3 (L (btps)) MA 0.0535*H(cm)-0.0271*... P-1.02 0
fev3 (L (btps)) FA 0.0442*H(cm)-0.0257*... P-0.62 0
fef2575 (L/s) MA 0.0204*H(cm)-0.0380*... P-1.67 0
fef2575 (L/s) FA 0.0154*H(cm)-0.0460*... P-1.36 0
fev1_fvc (%) MA -0.1300*H(cm)-0.152*... P-8.3 0
Close

Figure 10-19. The Predicted Equation Test Dialog

The Predicted Equation Test dialog will be displayed. The name of the equation selected when entering the Testing mode will be displayed in the title header – in this case CRAPOCI.

The Testing dialog contains two frames in the top half of the window and a full window data grid occupies the bottom half of the window. The left-upper pane is labeled Patient Parameters and contains text boxes for gender, height, weight, age, and BP (barometric pressure.) The right-upper pane is labeled Equation Information and contains age range and gender data that is informational only: It is not used directly during testing.

The bottom data grid contains a scrollable list for the currently selected equation name of all available parameters, the gender-age range, the equation, upper and lower limits where they exist, and the Residual Standard Deviation (RSD).

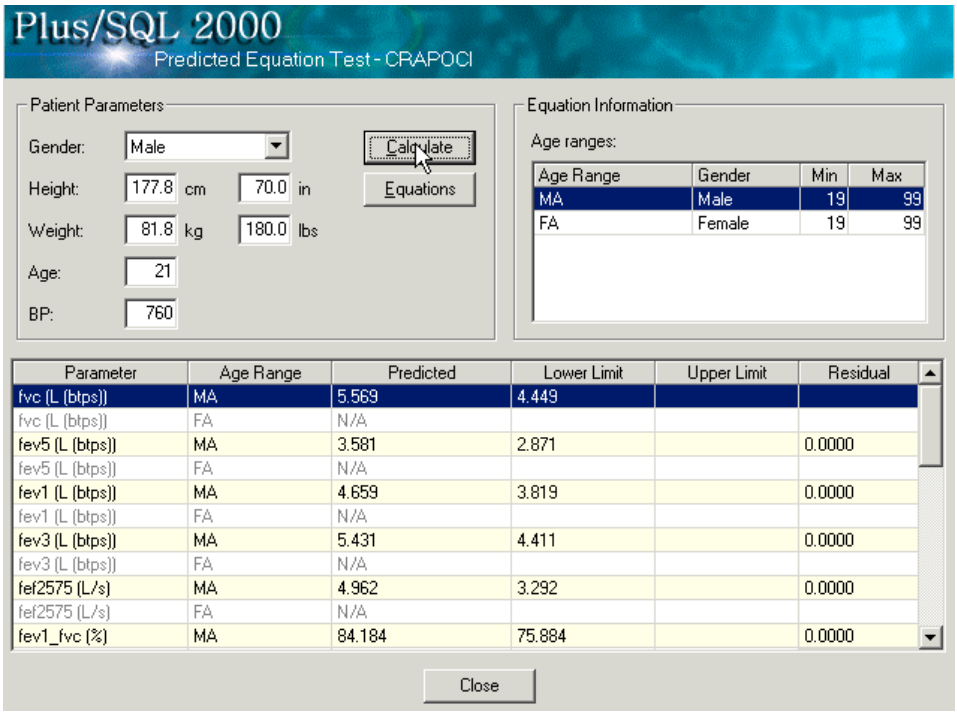

Plus/SQL 2000
Predicted Equation Test - CRAPOCI
Patient Parameters
Gender: Male
Height: 177.8 cm 70.0 in
Weight: 81.8 kg 180.0 lbs
Age: 21
BP: 760
Calculate
Equations
Equation Information
Age ranges:
Age Range Gender Min Max
MA Male 19 99
FA Female 19 99
Parameter Age Range Predicted Lower Limit Upper Limit Residual
fvc (L (btps)) MA 5.569 4.449
fvc (L (btps)) FA N/A
fev5 (L (btps)) MA 3.581 2.871 0.0000
fev5 (L (btps)) FA N/A
fev1 (L (btps)) MA 4.659 3.819 0.0000
fev1 (L (btps)) FA N/A
fev3 (L (btps)) MA 5.431 4.411 0.0000
fev3 (L (btps)) FA N/A
fef2575 (L/s) MA 4.962 3.292 0.0000
fef2575 (L/s) FA N/A
fev1_fvc (%) MA 84.184 75.884 0.0000
Close

Figure 10-20. Clicking on the Calculate Button in the Predicted Equation Test Dialog

When appropriate demographic data is entered into the text boxes in the Patient Parameters frame, clicking the Calculate button will cause the editor to perform the calculations for all parameters based on the entered demographic data. The predicted mean values for all gender-age ranges that meet the demographic criteria will be highlighted. Parameter equations that do not meet all criteria will be 'grayed out' and the value for the mean predicted will be listed as N/A.

While in the Test dialog, if the editor is in the Equation mode, double-clicking on the equation will pop up the Equation Script Editor with the equation contained in the clicked field displayed. This action will not occur if the editor is in the Protocol mode. You must switch to Equation mode and select the equation from the parameter list to edit it.

Demographic data may be modified as desired. Once all modified demographic values have been entered, click the Calculate button again to update the calculations.

Clicking the Equations button will revert all parameters back to the mean predicted format.

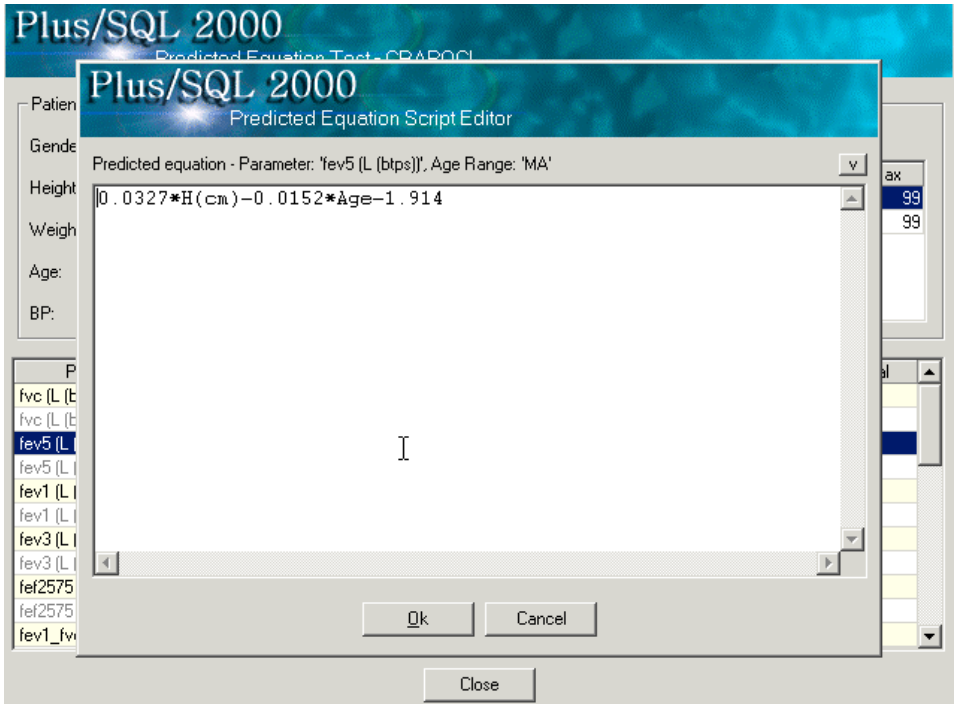



Figure 10-21. Using the Script Editor in the Equations Test Dialog

Double-clicking on any predicted equation will popup the Predicted Equation Script Editor showing the equation for the field double-clicked. The equation may be modified as desired and the changes accepted by clicking OK. The Script Editor dialog window will be dismissed and the equation in the testing dialog will be updated. Clicking the Calculate button will recalculate the equation to demonstrate the effects of the equation modification. This capability permits experimentation and is convenient in debugging equations and functions.

### The Handling of Parameter Units:

Internally the Predicted Equations Editor defines a base-unit for each parameter and uses this unit internally for all calculations. This means that at the protocol level, the base-unit will always be used. However, at the equation level as is used in the Testing mode, all parameters are displayed with the units selected at the time the equation was entered. This approach enables PLUS/2000 to handle the tracking and inter-conversion of all predicted equation parameter units ensuring that these units will be consistent with the units selected for the measured values of each parameter. Thus, for example, the situation of the mean predicted value of the Dsb being reported in SI units, while the measured values reported for that parameter are in traditional units, resulting in nonsensical values for the percent of predicted should not occur.

### Database Utilities – Predicted Tab

The GoTo/Database Utilities option has been extended to include a tab labeled Predicteds. The predicted tab enables the equations and protocols contained in the .xml files created by the Predicted Equation/Protocol Editor to be imported into a PLUS/2000 database and equations and protocols contained in a database to be exported to an .xml file that can be used to migrate predicteds data among other PLUS/2000 systems. Selecting the Predicteds tab will bring up the dialog window shown below.

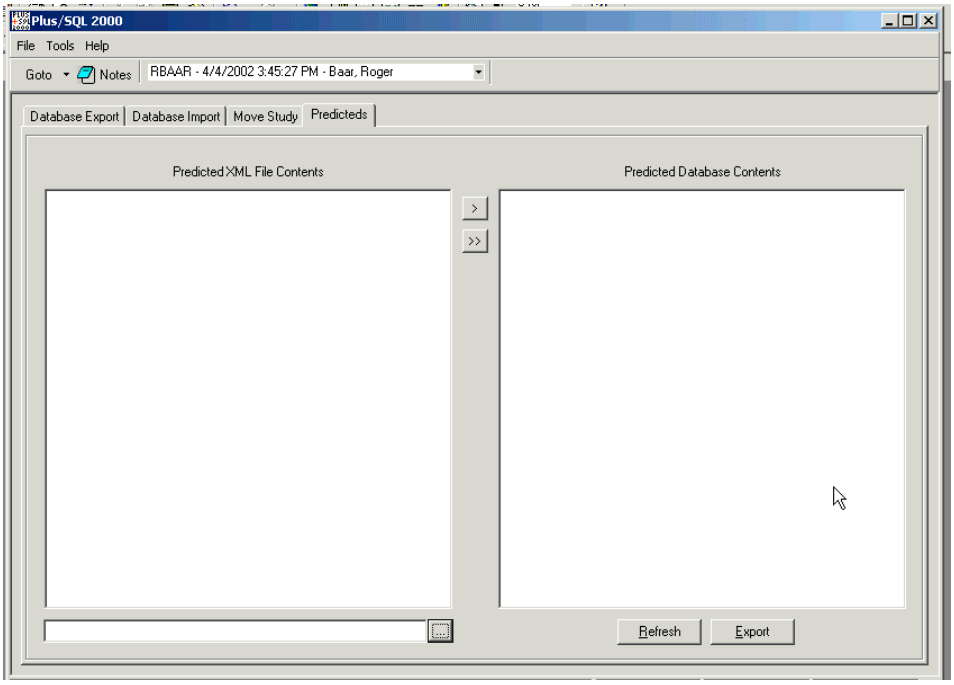



Figure 10-22. Selecting the Predicted Tab in the Database Utilities Option

## Importing Predicted Equations and/or Protocols to a PLUS/2000 Database

The Predicteds dialog window contains two main data panes and a text box that indicates the source of the .xml file. Below the left pane is a text box with a button containing three dots to its right. Clicking this button displays a standard Windows® open file dialog window labeled 'Predicteds XML Files.

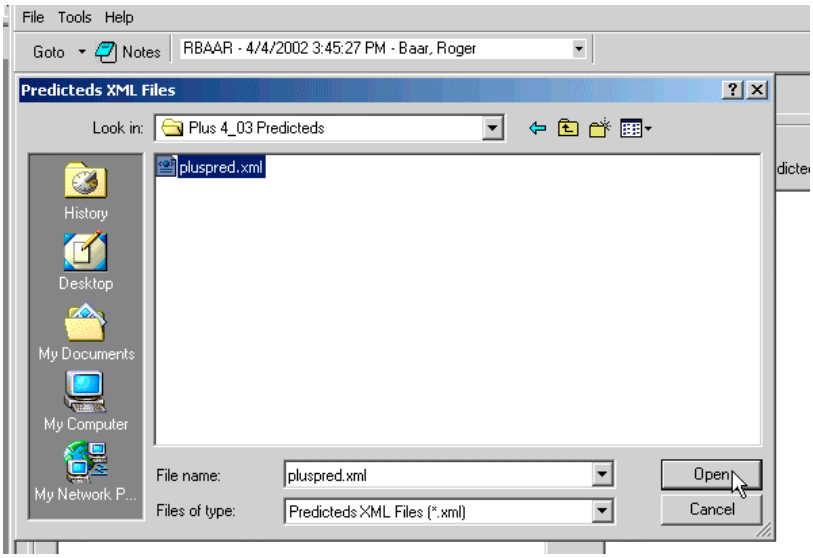



Figure 10-23. Selecting an .xml File from which to Import Predicteds

The process of importing predicteds data into a PLUS/2000 database begins by opening an .xml file containing the desired equations and/or protocols. To open the file, select the folder containing the file you wish to open in the 'Look in' text box, highlight the desired file from the list of available .xml files, and click the Open button. The selected file will be opened and the contents of the file will be displayed in the left 'Predicteds XML File Contents' pane in the standard Windows® tree format with all entries initially collapsed. The source folder for the file just opened will be displayed in the text box below the left pane. In the screen shot below, the Protocol entry has been expanded to show the protocols contained in the open file.

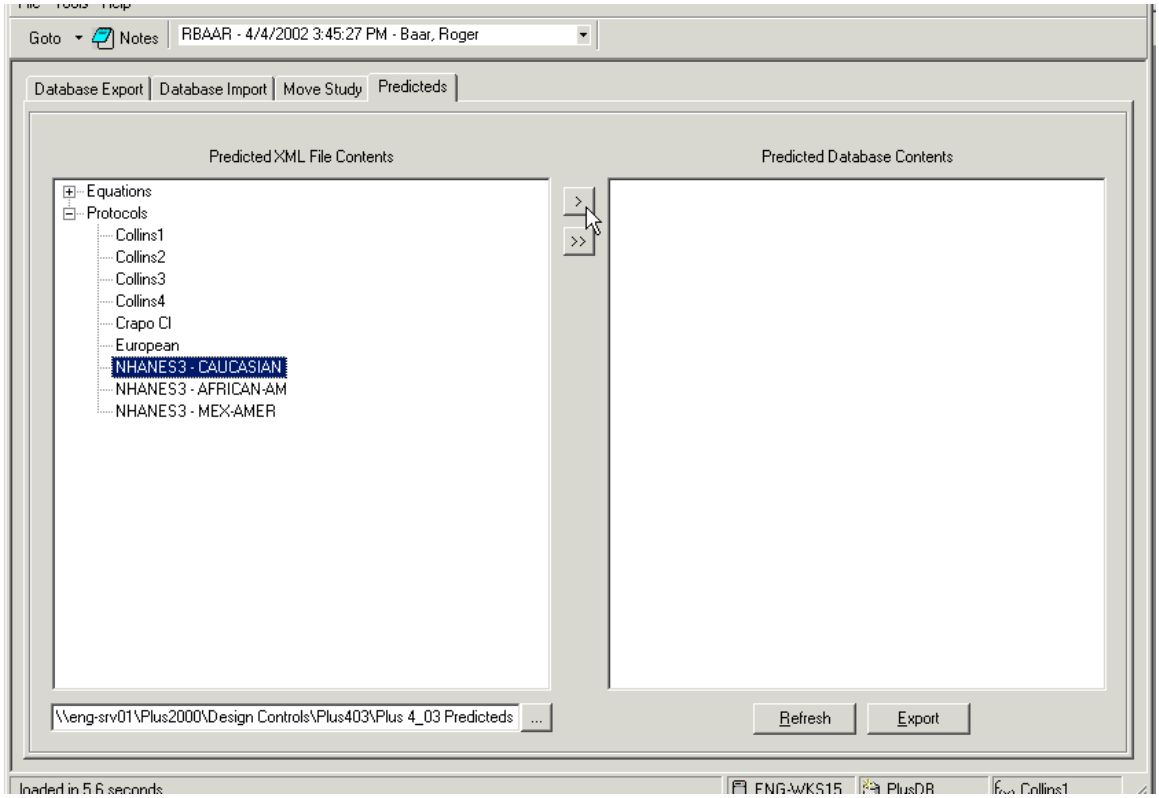



Figure 10-24. Selecting Equations and/or Protocols for Import into the Current PLUSDB Database

Select individual equations and/or protocols for import into the currently selected PlusDB database by clicking on the desired equation or protocol names. Multiple entries can be selected by following the standard Windows® procedure of holding down the <Ctrl> key as additional selections are made. *Selecting a protocol will automatically cause all equations called for by that protocol to be imported; it is not necessary to select all the individual equations called for by a protocol*. Once the desired equations and/or protocols are selected, click on the button with the single right-pointing arrow located between the two main data panes. A message will be displayed informing the user that the import operation may take several minutes. When the message is cleared by clicking its OK button, the import will begin. The progress of the import procedure will be displayed on a status bar located at the bottom left of the dialog window. Clicking on the button with two right-pointing arrows will cause all equations and protocols of the currently opened .xml file to be imported to the database, regardless of what of is selected.

## Exporting Predicted Equations and/or Protocols

The Predicteds tab also enables equations and protocols to be exported from the currently connected database to an .xml file. Clicking on the Refresh button located beneath the 'Predicted Database Contents' data pane on the right of the dialog window, will display a standard Windows® tree containing an initially collapsed list all predicted equations and protocols contained in the database. Clicking on the '+' to the left of the Equations and/or Protocols entries will expand the entries to reveal a complete list of all equations and protocols. As with importing to a database, select the desired protocols and/or equations, then click the Export button located under the pane.

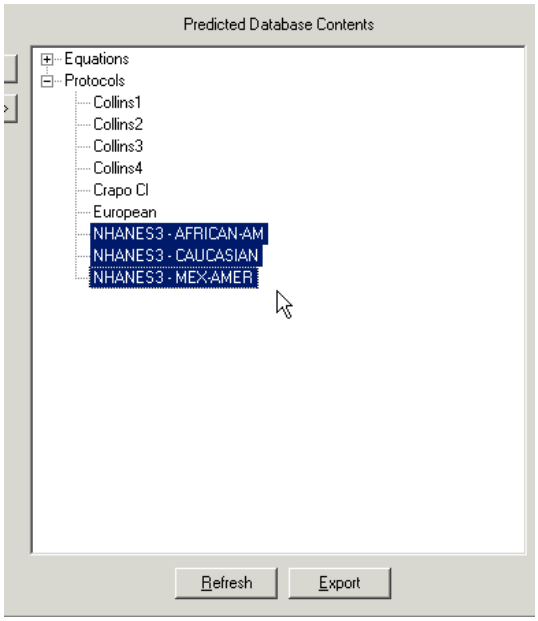



Figure 10-25. Selecting Predicted Equations and/or Protocols for Export to an .xml file

A standard Windows® Save dialog with the 'Save as type:' file type defaulted to .xml will be displayed. Select the destination for the file in the 'Save in:' text box, enter a file name in the 'File name:' text box and click the Save button. As with the Import to database functionality, all equations required by a selected protocol will be automatically exported; there is no need to select individual equations unless it is desired to export equations that are not part of a selected protocol.

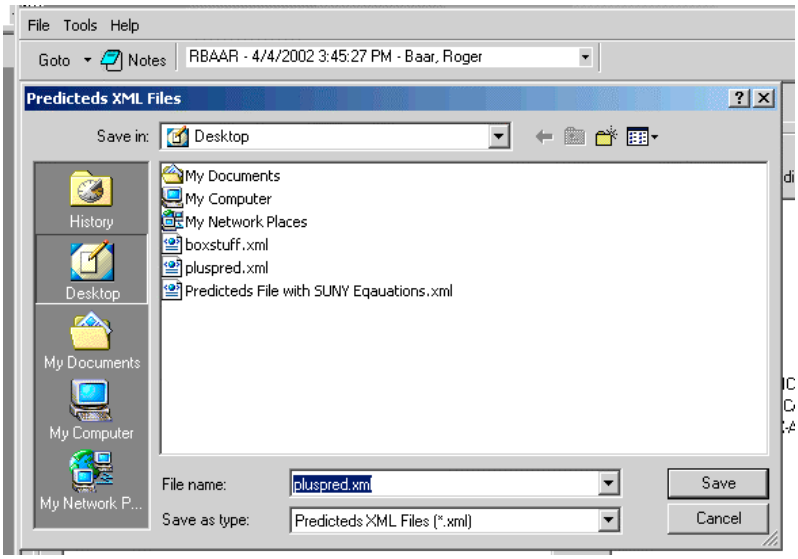



Figure 10-26. Selecting a Destination .xml file for Predicteds Export

The progress of the file export will be displayed in the status area located at the lower left of the Predicted tab dialog window.

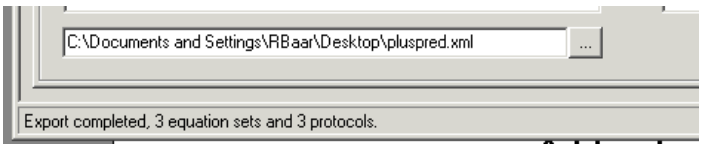



Figure 10-27. Status of Predicteds Export Displayed

## Summary of VBScript Operators and Rules

This addendum contains a summary of VBScript Operators and precedence rules for mathematical calculations. Full VBScript documentation is available on-line at

http://msdn.microsoft.com/library

Search for VBScript.

Visual Basic Scripting Edition

VBScript Operators
VBScript has a full range of operators, including arithmetic operators, comparison operators, concatenation operators, and logical operators.
Operator Precedence
When several operations occur in an expression, each part is evaluated and resolved in a predetermined order called operator precedence. You can use parentheses to override the order of precedence and force some parts of an expression to be evaluated before others. Operations within parentheses are always performed before those outside. Within parentheses, however, standard operator precedence is maintained. When expressions contain operators from more than one category, arithmetic operators are evaluated first, comparison operators are evaluated next, and logical operators are evaluated last. Comparison operators all have equal precedence; that is, they are evaluated in the left-to-right order in which they appear. Arithmetic and logical operators are evaluated in the following order of precedence.
Arithmetic
Description
Symbol

Exponentiation
^

Unary negation
-

Multiplication
*

Division
/

Integer division
\

Modulus arithmetic
Mod

Addition
+

Subtraction
-

String concatenation
&

Comparison
Description
Symbol

Equality
=

Inequality
<>
Less than
<

Greater than
>

Less than or equal to
<=

Greater than or equal to
>=

Object equivalence
Is

Logical
Description
Symbol

Logical negation
Not

Logical conjunction
And

Logical disjunction
Or

Logical exclusion
Xor

Logical equivalence
Eqv

Logical implication
Imp

When multiplication and division occur together in an expression, each operation is evaluated as it occurs from left to right. Likewise, when addition and subtraction occur together in an expression, each operation is evaluated in order of appearance from left to right.

# APPENDIX A -- LICENSING AGREEMENT

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# APPENDIX B -- REVIEW OF PULMONARY FUNCTION TERMINOLOGY

**NOTE:**
The following review of pulmonary function terminology is included to help users who are not readily familiar with pulmonary function testing and its accompanying specialized vocabulary.

Lung volumes and capacities are measurable values obtained during pulmonary function testing on the Collins CPL system. Changes in these values above or below a normal range are important indicators for diagnosing the existence and severity of pulmonary disease.

## Testing Operations

Testing operations on the CPL can be divided into three areas: Mechanics of Breathing, Lung Volumes, and Diffusing Capacity. Mechanics of Breathing is further divided into three maneuvers from which several tests can be calculated. The maneuvers are the Forced Expired Volume, FEV (also called Forced Vital Capacity, FVC), the Maximum Voluntary Ventilation (MVV), and the Slow Vital Capacity (SVC) and Tidal Volume (TV) maneuver.

This review section provides definitions of the pulmonary function terms involved in each maneuver.

## Mechanics of Breathing

### Forced Expired Volume (FEV) or Forced Vital Capacity (FVC) Maneuver

The following terminology is associated with the *Forced Vital Capacity* maneuver

**Forced Vital Capacity (FVC)** -- A vital capacity performed with a maximally forced expiratory effort from the point of maximum inspiration; i.e., as hard and as fast as possible. From this single tracing, the following flow rates and flow volumes can be determined: $FEV_{0.5}$, $FEV_1$, $FEV_2$, $FEF_{25-75}$, $FEF_{200-1200}$, and $FEV_t$/FVC%.

**Forced Expired Volume Timed (FEVt)** -- The volume of air expired in a specified time (in seconds or fractions of a second) during the Forced Vital Capacity. Generally, $FEV_{0.5}$, $FEV_1$, and $FEV_3$ are the most commonly measured values, although $FEV_2$ can also be measured.

**Mean Mid-Expiratory Flow ($FEF_{25-75\%}$)** -- The average forced expiratory flow during the middle half of the FVC. This measurement was formerly called the maximum mid-expiratory flow rate (MMEFR).

**Mean Forced Expiratory Flow ($FEF_{200-1200}$)** -- The average forced expiratory flow between 200 ml and 1200 ml of the FVC. This measurement was formerly called the maximum expiratory flow rate (MEFR).

**$FEV_t$/FVC%** -- The ratio of Forced Expiratory Volume timed, to FVC, expressed as a percentage.

**NOTE:**
All of the above parameters can also be measured from an inspiration starting at RV and ending at TLC.

### Maximum Voluntary Ventilation (MVV) Maneuver

**Maximum Voluntary Ventilation (MVV)** -- The total volume of air expired during a specified period with repetitive maximal respiratory effort. A MVV maneuver should be performed for some period of seconds which easily converts to one minute, such as 10, 12, or 15 seconds. Note however, that ATS recommends that the MVV maneuver last no less than 12 seconds and no longer than 15 seconds.

**Slow Vital Capacity (SVC) and Tidal Volume (TV) Maneuver**

The SVC maneuver can be performed separately or in conjunction with a helium dilution (FRC) maneuver. Refer to Figure b-1 for an illustration of the accompanying terminology.

**Vital Capacity (VC) or Slow Vital Capacity (SVC)** -- The maximum volume of air expired from the point of maximum inspiration without attention to speed. However, a maximal effort is still required through the end-expiration. The tracing produced by this modified procedure cannot be analyzed for flow rates; the only meaningful data is that for SVC.

**Tidal Volume (TV)** -- The volume of air expired or inspired with each breath during normal, quiet breathing.

**Expiratory Reserve Volume (ERV)** -- The maximum volume of air expired from the end-expiratory level of a tidal volume.

**Inspiratory Capacity (IC)** -- The maximum volume of air inspired from the end-expiratory level of a tidal volume. The inspiratory capacity can also be stated as the sum of TV and the inspiratory reserve volume. As explained below, IRV is not a common measurement; therefore, IC is usually measured from the tracing.

## Lung Volumes

Figure b-1 depicts lung volumes and capacities with the accompanying definitions.

**Slow Vital Capacity (SVC)** -- See earlier section.

**Tidal Volume (TV)** -- See earlier section.

**Expiratory Reserve Volume (ERV)** -- See earlier section.

**Functional Residual Capacity (FRC)** -- The volume of air remaining in the lungs at the end-expiratory position (after a normal, quiet inhalation); this is calculated as the sum of the residual volume (RV) and the expiratory reserve volume (ERV).

**Residual Volume (RV)** -- The volume of air remaining in the lungs after a maximum (forced) expiration; this volume cannot be removed from the lungs voluntarily.

**Total Lung Capacity (TLC)** -- The maximal amount of air the lungs can hold, including VC and RV. The lungs at their "total capacity" at the end of a maximal inspiration.

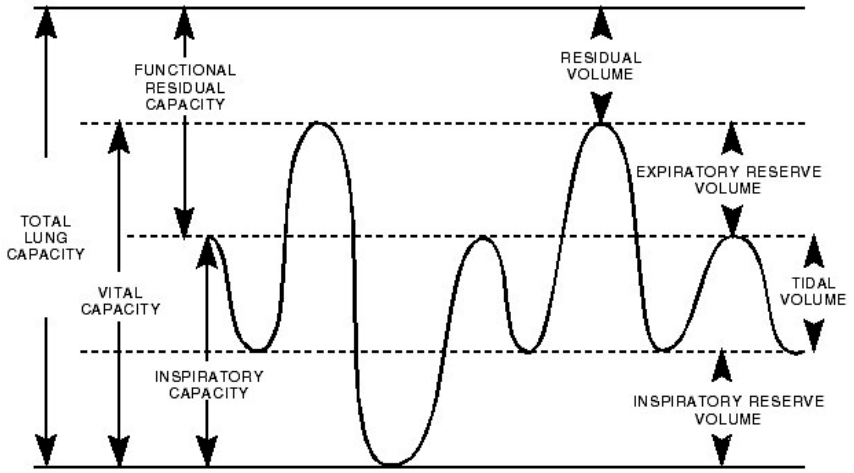


Figure B-1 Lung Volumes and Capacities

## Diffusing Capacity

The following values can be calculated from one properly performed Single Breath Diffusing Capacity (DSB ) test:

**DL(RB) or DCO** -- The volume of gas (in milliliters STPD) that can diffuse across the alveolar-capillary membrane per minute per mmHg of mean pressure gradient; this volume can be derived by using a lung volume from a helium equilibration test (FRC or RV).

**DL(SB)** -- The volume of gas (in milliliters STPD) that can diffuse across the alveolar-capillary membrane per minute per mmHg of mean pressure gradient. This volume is derived using the lung volume from a single breath dilution of an inert tracer gas (i.e., He, CH4).

**VA(RB)** -- The alveolar volume (total lung capacity) as determined by the helium rebreathing method.

**VA(SB)** -- The alveolar volume (BTPS corrected) as derived from the single breath maneuver.

**DL/VA** -- Rate of carbon monoxide uptake normalized to lung volume, that is, without regard to lung volume. DL is at STPD and VA is at BTPS.

**Inspired Volume** -- Also called VI or VINSP, ATPS corrected; this term defines the amount of air inspired from the point of maximum expiration to the point of maximum inspiration during the DLSB test.

**VI1/2** -- This point represents the mid-inspiration point of the inspired volume during the DLSB test; one method of determining breath-holding time, that of the Epidemiological Standardization Project (ESP) has breath-holding time beginning at this point.

**Breath-holding Time** -- Also called T or BHT; this measurement, recommended to last between 9-11 seconds, can be determined according to several different methods. The standards applied in the DSB test with the Collins CPL are those of the American Thoracic Society. Collins therefore employs the Jones-Meade method of measuring Breath-hold Time (BHT). With this method, the BHT is measured from one third of the way through inspiration to halfway through the sample collection.

**Washout Volume** -- The volume of air expired during the DLSB test that corresponds to the anatomical dead space (the portion of the breathing network where diffusion does not take place; usually equal to the patient's height in centimeters in a normal individual). ATS suggests taking a washout volume of between 750 ml. (.75 liters) and 1,000 ml. (1 liter), depending on the individual vital capacity; for patients with a vital capacity of less than 2 liters, a washout volume of 500 ml. can be used. Washout volume is not analyzed.

## Symbols Used for Respiratory Physiology

### LARGE CAPITALS

- V - gas volume
- F - fractional concentration of gas
- Q - volume of blood
- S - percentage saturation hemoglobin with $O_2$
- P - partial pressure of gas or its tension

### SMALL CAPITALS

- I - inspired gas
- E - expired gas
- A - alveolar gas
- B - barometric
- D - dead space gas
- T - tidal volume gas

STPD - 0° Celsius, 760 mmHg, dry

BTPS - body temperature and pressure, saturated with water vapor

ATPS - ambient temperature and pressure, saturated with water vapor.

**LOWER CASE**

a - arterial blood
c - venous blood
f - frequency

**SPECIAL SYMBOLS**

dash above - mean value
dot above - derivative

## Equations for BTPS, STPD and STPD37 Correction

$$BTPS = \frac{BP - PH_2O}{BP - 47.1} \times \frac{310}{273 + t}$$

$$STPD = \frac{BP - PH_2O}{760} \times \frac{273}{273 + t}$$

$$STPD37 = \frac{BP - 47.1}{760} \times \frac{273}{310}$$

where,

BP = barometric pressure
$PH_2O$ = vapor pressure of water at spirometer temperature
t = spirometer temperature
47.1 = vapor pressure of $H_2O$ at 37° Celsius
310 = absolute body temperature degrees Kelvin
273 = degrees Kelvin at 0° Celsius

## CPL Pulmonary Modules -- Basic Theory

### Spirometry

Typically, a pulmonary function system is equipped with either a pneumotach or a spirometer, or both. Figure b-2 shows a cross-section of the breathing circuit in a stand-alone spirometer to aid you in understanding how a spirometer works. With a spirometer, measurements of basic lung volumes and capacities are made as follows:

As the patient breathes through the mouthpiece (A), the expired (or inspired) gas flows through the breathing tube and the internal tubing (B and C). The expired gas empties inside the spirometer bell (D) and forces it to rise. Traditionally, the bell-mounted recording pen (E), moving with the bell, records the breathing maneuver on a kymograph, which is a revolving drum containing chart paper (F). With a direct-writing spirometer bell, such as the one used in the CPL system, an inspiration is recorded as a downstroke and an expiration as an upstroke. Collins spirometers come in either a water-sealed or a dry-sealed model. The water-sealed bell rides in a narrow well of water. The dry seal spirometer is equipped with a seal attached to the bell. Either method is effective in preventing air from escaping from the bell.

Figure B-2. Cross-Section of the Breathing Circuit in a Basic Spirometer

Instead of a kymograph, or in addition to one, many spirometers today are equipped with a linear motion potentiometer. This electronic device is attached to the bell and thereby provides an output voltage that corresponds to the movement of the bell. In this way, bell volumes can be read and calculated by a computer connected to the spirometer. The Collins CPL with Spirometer contains such a spirometer/potentiometer/computer system for making measurements of basic spirometry parameters, such as Forced Vital Capacity, Slow Vital Capacity, and for calculating lung volumes.

The CPL Balloon Valve automates a variety of pulmonary function test procedures (such as raising and lowering of spirometer at appropriate moments during the test sequence).

These spirometry measurements can also be made with the use of the pneumotach, in this case, the Collins pneumotach. The patient breathes through the pneumotach, which is a device that measures flow across a flow-resistive element, in this case, the pneumotach screen. The inspired or expired flow reading is then integrated into a volume reading with the aid of a computer.

The MIPS/MEPS feature in the CPL allows the user to make measurements of the patient's maximum inspiratory pressure and maximum expiratory pressure through the use of a pressure sensor in the module. These terms refer to the maximum pressure attained by the patient during either inspiration or expiration.

## Lung Volumes

The CPL allows for measurement of lung volumes in addition to simple spirometry. Several key lung volumes are defined below:

**Tidal Volume (TV):** The volume of air breathed in or out of the lungs during normal breathing.

**Functional Residual Capacity (FRC):** The volume of air left in the lungs at the end of expiration during normal breathing.

**FRC** is composed of the following two volumes:

The **Expiratory Reserve Volume (ERV)**: the maximal additional volume of air that can be exhaled following a normal expiration to FRC.

The **Residual Volume (RV)**: the volume of air remaining in the lungs at the end of a maximal exhalation.

While most lung volumes can be determined via simple spirometry, RV cannot be measured directly via spirometry. Instead, FRC is determined by indirect means and RV is arrived at by subtracting ERV from FRC.
Collins offers two methods of measuring FRC. One is via the body plethysmograph, which is not included in this particular discussion. The other is the closed-circuit helium dilution method available with CPL. This method involves the dilution of helium, an inert, soluble gas, as it mixes with the air in the lungs. To begin with, the spirometer is filled with a mixture of approximately 10% helium in air. At exactly the end-expiratory level, the patient starts breathing this mixture from the closed spirometry system. As the helium mixes with the additional air in the lungs, it becomes more dilute. Since helium does not cross the alveolar-capillary membrane, the volume of helium remains the same during the test period. Therefore, the initial concentration ($He_{initial}$) multiplied by the volume of gas in the spirometer at the start of the test ($V_{spirometer}$) equals the final concentration of helium ($He_{final}$) multiplied by the volume of gas in the spirometer at the end of the test plus the volume of air in the lungs, which is FRC. The equation can be written and solved for FRC as follows:

$$He_{initial} \times V_{spirometer} = He_{final} \times (V_{spirometer} + FRC)$$

$$FRC = \frac{V_{spirometer} \times (He_{initial} - He_{final})}{He_{final}}$$

The $O_2$ consumed by the patient during the test is replaced by automatically adding $O_2$ to the spirometer bell. The Balloon Valve makes various gasses ($O_2$, Helium, room air) available to the spirometer as required by the program. The excess carbon dioxide expelled by the patient is absorbed by the container of soda lime attached to the system. The concentration of helium in the system is determined by use of a helium meter. The above calculations are conducted very rapidly with the CPL system's PLUS software program and the computer.

## Diffusing Capacity

Diffusing capacity of the lung is a measure of the lung's ability to conduct a gas, such as $O_2$, from the alveoli to the capillary blood. Diffusing capacity is reduced when alveolar walls are destroyed and pulmonary capillaries are obliterated by emphysema and when the alveolar-capillary membrane is thickened by edema, consolidation, or fibrosis.

The method used by the conventional DL module to determine diffusing capacity of the lungs involves the use of carbon monoxide (CO), since it has diffusing characteristics similar to those of $O_2$ and because of the great affinity of CO for hemoglobin. There are several methods available for measuring the diffusing capacity of the lung for CO ($DL_{CO}$). The one employed by the conventional DL module is the single-breath method. In this method, the patient takes in a very low concentration of CO in a single inspiration and follows this by a 10-second breath-holding period. He then exhales into a sample bag. Inspired and expired concentrations of CO are measured using a CO meter, the volume of gas in the lungs is determined via helium dilution during the single breath maneuver, and the rate of carbon monoxide uptake from the lung is calculated by the software.

The microGA Realtime Response method of measuring lung diffusion, which is the one currently used by Collins in the CPL system, also employs the single-breath maneuver and CO as the tracer gas. However, the patient does not exhale into a sample bag; rather the gas content is sampled instantaneously, at the mouth, as exhalation occurs, with a rapid-response analyzer. In this method, methane ($CH_4$) is used in place of helium for measuring lung volume by gas dilution during the maneuver. A tracing of gas concentrations during the maneuver is displayed along with the volume tracing, thereby allowing the user to determine where washout occurred and sample collection began. The same equation is used for determining DLSB as for the conventional method; however, $CH_4$ is substituted for He.

## APPENDIX C -- PREDICTED PROTOCOL LISTINGS AND AUTHOR REFERENCES

### References for Prediction Equations

The PLUS/2000 Predicted Equation Program consists of the following Protocols, or sets:

Collins 1
Collins 2
Collins 3
Collins 4
Crapo CI
European
NHANES3 – AFRICAN-AM
NHANES3 – CAUCASIAN
NHANES3 – MEX-AMER

Below is a listing of each of the authors in the PLUS/2000 Predicted Protocols, along with the sources for their equations. Following these references is a listing of the parameters and authors in each Protocol, along with the accompanying sex and age categories.

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## Predicted Equation Authors for the PLUS/2000 Protocols

Following is a listing of the authors for each parameter in the Protocols provided by the PLUS/2000 program. Also included are the sex and age ranges for each parameter. You may view the actual equations by using the Collins Predicted Equations Editor, as described in Section Eight.

The PLUS/2000 Predicted Equation Program consists of the following Protocols, or sets:

Collins 1
Collins 2
Collins 3
Collins 4
Crapo CI
European
NHANES3 – AFRICAN-AM
NHANES3 – CAUCASIAN
NHANES3 – MEX-AMER

Figure C-1 Predicted Equation Authors for the PLUS/2000 Protocols

| Protocol Set | Parameter | Sex/Age Category | Sex | Min Age | Max Age | Author |
|---|---|---|---|---|---|---|
| Collins1 | fvc | FA | FEMALE | 18 | 99 | MORRIS(FA) |
| Collins1 | fvc | MA | MALE | 18 | 99 | MORRIS(MA) |
| Collins1 | fvc | FC | FEMALE | 5 | 11 | DICKMAN(FC) |
| Collins1 | fvc | MC | MALE | 5 | 11 | DICKMAN(MC) |
| Collins1 | fvc | FD | FEMALE | 12 | 17 | DICKMAN(FD) |
| Collins1 | fvc | MD | MALE | 12 | 17 | DICKMAN(MD) |
| Collins1 | fev5 | MA | MALE | 18 | 99 | KORY(MA) |
| Collins1 | fev1 | FA | FEMALE | 18 | 99 | MORRIS(FA) |
| Collins1 | fev1 | MA | MALE | 18 | 99 | MORRIS(MA) |
| Collins1 | fev1 | FC | FEMALE | 5 | 11 | DICKMAN(FC) |
| Collins1 | fev1 | MC | MALE | 5 | 11 | DICKMAN(MC) |
| Collins1 | fev1 | FD | FEMALE | 12 | 17 | DICKMAN(FD) |
| Collins1 | fev1 | MD | MALE | 12 | 17 | DICKMAN(MD) |
| Collins1 | fev3 | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins1 | fef2575 | FA | FEMALE | 18 | 99 | MORRIS(FA) |
| Collins1 | fef2575 | MA | MALE | 18 | 99 | MORRIS(MA) |
| Collins1 | fef2575 | FC | FEMALE | 5 | 11 | DICKMAN(FC) |
| Collins1 | fef2575 | MC | MALE | 5 | 11 | DICKMAN(MC) |
| Collins1 | fef2575 | FD | FEMALE | 12 | 17 | DICKMAN(FD) |
| Collins1 | fef2575 | MD | MALE | 12 | 17 | DICKMAN(MD) |
| Collins1 | fefmax | FC | FEMALE | 5 | 11 | DICKMAN(FC) |
| Collins1 | fefmax | MC | MALE | 5 | 11 | DICKMAN(MC) |
| Collins1 | fefmax | FD | FEMALE | 12 | 17 | DICKMAN(FD) |
| Collins1 | fefmax | MD | MALE | 12 | 17 | DICKMAN(MD) |
| Collins1 | fefmax | FA | FEMALE | 18 | 99 | CHERNIAK(FA) |
| Collins1 | fefmax | MA | MALE | 18 | 99 | CHERNIAK(MA) |
| Collins1 | fef25 | MD | MALE | 12 | 17 | ZAPLETAL(MD and MC) |
| Collins1 | fef25 | FC | FEMALE | 5 | 11 | ZAPLETAL(MD and MC) |
| Collins1 | fef25 | MC | MALE | 5 | 11 | ZAPLETAL(MD and MC) |
| Collins1 | fef25 | FD | FEMALE | 12 | 17 | ZAPLETAL(FD and FC) |
| Collins1 | fef25 | FA | FEMALE | 18 | 99 | CHERNIAK(FA) |
| Collins1 | fef25 | MA | MALE | 18 | 99 | CHERNIAK(MA) |
| Collins1 | fef50 | MD | MALE | 12 | 17 | ZAPLETAL(MD and MC) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Collins1 | fef50 | MC | MALE | 5 | 11 | ZAPLETAL(MD and MC) |
| Collins1 | fef50 | FD | FEMALE | 12 | 17 | ZAPLETAL(FD and FC) |
| Collins1 | fef50 | FC | FEMALE | 5 | 11 | ZAPLETAL(FD and FC) |
| Collins1 | fef50 | FA | FEMALE | 18 | 99 | CHERNIAK(FA) |
| Collins1 | fef50 | MA | MALE | 18 | 99 | CHERNIAK(MA) |
| Collins1 | fef75 | MD | MALE | 12 | 17 | ZAPLETAL(MD and MC) |
| Collins1 | fef75 | MC | MALE | 5 | 11 | ZAPLETAL(MD and MC) |
| Collins1 | fef75 | FD | FEMALE | 12 | 17 | ZAPLETAL(FD and FC) |
| Collins1 | fef75 | FC | FEMALE | 5 | 11 | ZAPLETAL(FD and FC) |
| Collins1 | fef75 | FA | FEMALE | 18 | 99 | CHERNIAK(FA) |
| Collins1 | fef75 | MA | MALE | 18 | 99 | CHERNIAK(MA) |
| Collins1 | fev1_fvc | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins1 | fev3_fvc | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins1 | mvv | FA | FEMALE | 18 | 99 | CHERNIAK(FA) |
| Collins1 | mvv | MA | MALE | 18 | 99 | CHERNIAK(MA) |
| Collins1 | mvv | MC | MALE | 5 | 11 | WENG_LEV(Children and Teens) |
| Collins1 | mvv | MD | MALE | 12 | 17 | WENG_LEV(Children and Teens) |
| Collins1 | mvv | FD | FEMALE | 12 | 17 | WENG_LEV(Children and Teens) |
| Collins1 | mvv | FC | FEMALE | 5 | 11 | WENG_LEV(Children and Teens) |
| Collins1 | mip | MA | MALE | 18 | 99 | BLK_HYAT(MA) |
| Collins1 | mip | FA | FEMALE | 18 | 99 | BLK_HYAT(FA) |
| Collins1 | mep | MA | MALE | 18 | 99 | BLK_HYAT(MA) |
| Collins1 | mep | FA | FEMALE | 18 | 99 | BLK_HYAT(FA) |
| Collins1 | vc | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins1 | rv | MA | MALE | 18 | 99 | GOLDMAN(MA) |
| Collins1 | rv | FA | FEMALE | 18 | 99 | GOLDMAN(FA) |
| Collins1 | rv | MC | MALE | 5 | 11 | WENG_LEV(Children and Teens) |
| Collins1 | rv | MD | MALE | 12 | 17 | WENG_LEV(Children and Teens) |
| Collins1 | rv | FD | FEMALE | 12 | 17 | WENG_LEV(Children and Teens) |
| Collins1 | rv | FC | FEMALE | 5 | 11 | WENG_LEV(Children and Teens) |
| Collins1 | frc | MC | MALE | 5 | 11 | WENG_LEV(Children and Teens) |
| Collins1 | frc | MD | MALE | 12 | 17 | WENG_LEV(Children and Teens) |
| Collins1 | frc | FD | FEMALE | 12 | 17 | WENG_LEV(Children and Teens) |
| Collins1 | frc | FC | FEMALE | 5 | 11 | WENG_LEV(Children and Teens) |
| Collins1 | frc | FA | FEMALE | 18 | 99 | BATES(FA) |
| Collins1 | frc | MA | MALE | 18 | 99 | BATES(MA) |
| Collins1 | erv | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins1 | tlc | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins1 | ic | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins1 | rv_tlc | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins1 | dco | MA | MALE | 18 | 99 | GAENSLER(MA) |
| Collins1 | dco | FA | FEMALE | 18 | 99 | GAENSLER(FA) |
| Collins1 | dco | FD | FEMALE | 12 | 17 | MONTREAL(Children and Teens) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Collins1 | dco | FC | FEMALE | 5 | 11 | MONTREAL(Children and Teens) |
| Collins1 | dco | MC | MALE | 5 | 11 | MONTREAL(Children and Teens) |
| Collins1 | dco | MD | MALE | 12 | 17 | MONTREAL(Children and Teens) |
| Collins1 | dsb | MA | MALE | 18 | 99 | GAENSLER(MA) |
| Collins1 | dsb | FA | FEMALE | 18 | 99 | GAENSLER(FA) |
| Collins1 | dsb | MC | MALE | 5 | 11 | MONTREAL(Children and Teens) |
| Collins1 | dsb | MD | MALE | 12 | 17 | MONTREAL(Children and Teens) |
| Collins1 | dsb | FD | FEMALE | 12 | 17 | MONTREAL(Children and Teens) |
| Collins1 | dsb | FC | FEMALE | 5 | 11 | MONTREAL(Children and Teens) |
| Collins1 | va | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins1 | d_va | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins1 | raw | FA | FEMALE | 18 | 99 | CLAUSEN(Adults) |
| Collins1 | raw | MA | MALE | 18 | 99 | CLAUSEN(Adults) |
| Collins1 | raw | MC | MALE | 5 | 11 | WENG_LEV(Children and Teens) |
| Collins1 | raw | MD | MALE | 12 | 17 | WENG_LEV(Children and Teens) |
| Collins1 | raw | FD | FEMALE | 12 | 17 | WENG_LEV(Children and Teens) |
| Collins1 | raw | FC | FEMALE | 5 | 11 | WENG_LEV(Children and Teens) |
| Collins1 | sgaw | FA | FEMALE | 18 | 99 | CLAUSEN(Adults) |
| Collins1 | sgaw | MA | MALE | 18 | 99 | CLAUSEN(Adults) |
| Collins1 | ph | MA | MALE | 18 | 99 | ABG_SLEV0FT(20-99) |
| Collins1 | ph | FC | FEMALE | 5 | 11 | ABG_SLEV0FT(20-99) |
| Collins1 | ph | MC | MALE | 5 | 11 | ABG_SLEV0FT(20-99) |
| Collins1 | ph | MD | MALE | 12 | 17 | ABG_SLEV0FT(20-99) |
| Collins1 | ph | FD | FEMALE | 12 | 17 | ABG_SLEV0FT(20-99) |
| Collins1 | ph | FA | FEMALE | 18 | 99 | ABG_SLEV0FT(20-99) |
| Collins1 | hco3 | FC | FEMALE | 5 | 11 | ABG_SLEV(FC) |
| Collins1 | hco3 | MA | MALE | 18 | 99 | ABG_SLEV(MA) |
| Collins1 | hco3 | MD | MALE | 12 | 17 | ABG_SLEV(MD) |
| Collins1 | hco3 | FA | FEMALE | 18 | 99 | ABG_SLEV(FA) |
| Collins1 | hco3 | MC | MALE | 5 | 11 | ABG_SLEV(MC) |
| Collins1 | hco3 | FD | FEMALE | 12 | 17 | ABG_SLEV(FD) |
| Collins2 | fvc | MC and MD | MALE | 5 | 18 | KNUD1983(MC) |
| Collins2 | fvc | FA | FEMALE | 19 | 99 | KNUD1983(FA) |
| Collins2 | fvc | MA | MALE | 19 | 99 | KNUD1983(MA) |
| Collins2 | fvc | MD | MALE | 12 | 18 | KNUD1983(MD) |
| Collins2 | fvc | FD | FEMALE | 12 | 18 | KNUD1983(FD) |
| Collins2 | fvc | FC and FD | FEMALE | 5 | 18 | KNUD1983(FC) |
| Collins2 | fev1 | MC and MD | MALE | 5 | 18 | KNUD1983(MC) |
| Collins2 | fev1 | FA | FEMALE | 19 | 99 | KNUD1983(FA) |
| Collins2 | fev1 | MA | MALE | 19 | 99 | KNUD1983(MA) |
| Collins2 | fev1 | MD | MALE | 12 | 18 | KNUD1983(MD) |
| Collins2 | fev1 | FD | FEMALE | 12 | 18 | KNUD1983(FD) |

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|---|---|---|---|---|---|---|
| Collins2 | fev1 | FC and FD | FEMALE | 5 | 18 | KNUD1983(FC) |
| Collins2 | fev3 | FC and FD | FEMALE | 5 | 18 | KNUD1976(FD and FC) |
| Collins2 | fev3 | MC and MD | MALE | 5 | 18 | KNUD1976(MD and MC) |
| Collins2 | fev3 | MA | MALE | 19 | 99 | KNUD1976(MA) |
| Collins2 | fev3 | FA | FEMALE | 19 | 99 | KNUD1976(FA) |
| Collins2 | fef2575 | MC and MD | MALE | 5 | 18 | KNUD1983(MC) |
| Collins2 | fef2575 | FA | FEMALE | 19 | 99 | KNUD1983(FA) |
| Collins2 | fef2575 | MA | MALE | 19 | 99 | KNUD1983(MA) |
| Collins2 | fef2575 | MD | MALE | 12 | 18 | KNUD1983(MD) |
| Collins2 | fef2575 | FD | FEMALE | 12 | 18 | KNUD1983(FD) |
| Collins2 | fef2575 | FC and FD | FEMALE | 5 | 18 | KNUD1983(FC) |
| Collins2 | fefmax | FC and FD | FEMALE | 5 | 18 | KNUD1976(MD and MC) |
| Collins2 | fefmax | MC and MD | MALE | 5 | 18 | KNUD1976(MD and MC) |
| Collins2 | fefmax | MA | MALE | 19 | 99 | KNUD1976(MA) |
| Collins2 | fefmax | FA | FEMALE | 19 | 99 | KNUD1976(FA) |
| Collins2 | fef25 | FC and FD | FEMALE | 5 | 18 | KNUD1976(MD and MC) |
| Collins2 | fef25 | MC and MD | MALE | 5 | 18 | KNUD1976(MD and MC) |
| Collins2 | fef25 | MA | MALE | 19 | 99 | KNUD1976(MA) |
| Collins2 | fef25 | FA | FEMALE | 19 | 99 | KNUD1976(FA) |
| Collins2 | fef50 | MC and MD | MALE | 5 | 18 | KNUD1983(MC) |
| Collins2 | fef50 | FA | FEMALE | 19 | 99 | KNUD1983(FA) |
| Collins2 | fef50 | MA | MALE | 19 | 99 | KNUD1983(MA) |
| Collins2 | fef50 | MD | MALE | 12 | 18 | KNUD1983(MD) |
| Collins2 | fef50 | FD | FEMALE | 12 | 18 | KNUD1983(FD) |
| Collins2 | fef50 | FC and FD | FEMALE | 5 | 18 | KNUD1983(FC) |
| Collins2 | fef75 | MC and MD | MALE | 5 | 18 | KNUD1983(MC) |
| Collins2 | fef75 | FA | FEMALE | 19 | 99 | KNUD1983(FA) |
| Collins2 | fef75 | MA | MALE | 19 | 99 | KNUD1983(MA) |
| Collins2 | fef75 | MD | MALE | 12 | 18 | KNUD1983(MD) |
| Collins2 | fef75 | FD | FEMALE | 12 | 18 | KNUD1983(FD) |
| Collins2 | fef75 | FC and FD | FEMALE | 5 | 18 | KNUD1983(FC) |
| Collins2 | fev1_fvc | MC and MD | MALE | 5 | 18 | KNUD1983(MC) |
| Collins2 | fev1_fvc | FA | FEMALE | 19 | 99 | KNUD1983(FA) |
| Collins2 | fev1_fvc | MA | MALE | 19 | 99 | KNUD1983(MA) |
| Collins2 | fev1_fvc | MD | MALE | 12 | 18 | KNUD1983(MD) |
| Collins2 | fev1_fvc | FD | FEMALE | 12 | 18 | KNUD1983(FD) |
| Collins2 | fev1_fvc | FC and FD | FEMALE | 5 | 18 | KNUD1983(FC) |
| Collins2 | fev3_fvc | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins2 | mvv | MA | MALE | 19 | 99 | BALDWIN(MA) |
| Collins2 | mvv | FA | FEMALE | 19 | 99 | BALDWIN(FA) |

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|---|---|---|---|---|---|---|
| Collins2 | mvv | FC and FD | FEMALE | 5 | 18 | POLGAR71(Children and Teens) |
| Collins2 | mvv | MC and MD | MALE | 5 | 18 | POLGAR71(Children and Teens) |
| Collins2 | mip | MA | MALE | 19 | 99 | BLK_HYAT(MA) |
| Collins2 | mip | FA | FEMALE | 19 | 99 | BLK_HYAT(FA) |
| Collins2 | mep | MA | MALE | 19 | 99 | BLK_HYAT(MA) |
| Collins2 | mep | FA | FEMALE | 19 | 99 | BLK_HYAT(FA) |
| Collins2 | vc | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins2 | rv | MA | MALE | 19 | 99 | GOLDMAN(MA) |
| Collins2 | rv | FA | FEMALE | 19 | 99 | GOLDMAN(FA) |
| Collins2 | rv | FC and FD | FEMALE | 5 | 18 | WENG_LEV(Children and Teens) |
| Collins2 | rv | MC and MD | MALE | 5 | 18 | WENG_LEV(Children and Teens) |
| Collins2 | frc | MA | MALE | 19 | 99 | GOLDMAN(MA) |
| Collins2 | frc | FA | FEMALE | 19 | 99 | GOLDMAN(FA) |
| Collins2 | frc | FC and FD | FEMALE | 5 | 18 | WENG_LEV(Children and Teens) |
| Collins2 | frc | MC and MD | MALE | 5 | 18 | WENG_LEV(Children and Teens) |
| Collins2 | erv | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins2 | tlc | MA | MALE | 19 | 99 | GOLDMAN(MA) |
| Collins2 | tlc | FA | FEMALE | 19 | 99 | GOLDMAN(FA) |
| Collins2 | tlc | FC and FD | FEMALE | 5 | 18 | WENG_LEV(Children and Teens) |
| Collins2 | tlc | MC and MD | MALE | 5 | 18 | WENG_LEV(Children and Teens) |
| Collins2 | ic | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins2 | rv_tlc | MA | MALE | 19 | 99 | GOLDMAN(MA) |
| Collins2 | rv_tlc | FA | FEMALE | 19 | 99 | GOLDMAN(FA) |
| Collins2 | rv_tlc | FC and FD | FEMALE | 5 | 18 | WENG_LEV(Children and Teens) |
| Collins2 | rv_tlc | MC and MD | MALE | 5 | 18 | WENG_LEV(Children and Teens) |
| Collins2 | dco | MA | MALE | 19 | 99 | GAENSLER(MA) |
| Collins2 | dco | FA | FEMALE | 19 | 99 | GAENSLER(FA) |
| Collins2 | dco | FC and FD | FEMALE | 5 | 18 | MONTREAL(Children and Teens) |
| Collins2 | dco | MC and MD | MALE | 5 | 18 | MONTREAL(Children and Teens) |
| Collins2 | dsb | MA | MALE | 19 | 99 | GAENSLER(MA) |
| Collins2 | dsb | FA | FEMALE | 19 | 99 | GAENSLER(FA) |
| Collins2 | dsb | FC and FD | FEMALE | 5 | 18 | MONTREAL(Children and Teens) |
| Collins2 | dsb | MC and MD | MALE | 5 | 18 | MONTREAL(Children and Teens) |
| Collins2 | va | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins2 | d_va | Everyone | BOTH | 5 | 99 | COLLINS(Everyone) |
| Collins2 | raw | FA | FEMALE | 19 | 99 | CLAUSEN(Adults) |
| Collins2 | raw | MA | MALE | 19 | 99 | CLAUSEN(Adults) |
| Collins2 | raw | FC and FD | FEMALE | 5 | 18 | WENG_LEV(Children and Teens) |
| Collins2 | raw | MC and MD | MALE | 5 | 18 | WENG_LEV(Children and Teens) |

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|---|---|---|---|---|---|---|
| Collins2 | hco3 | FC and FD | FEMALE | 5 | 18 | ABG_SLEV(FC) |
| Collins2 | hco3 | MA | MALE | 19 | 99 | ABG_SLEV(MA) |
| Collins2 | hco3 | MD | MALE | 12 | 18 | ABG_SLEV(MD) |
| Collins2 | hco3 | FA | FEMALE | 19 | 99 | ABG_SLEV(FA) |
| Collins2 | hco3 | MC and MD | MALE | 5 | 18 | ABG_SLEV(MC) |
| Collins2 | hco3 | FD | FEMALE | 12 | 18 | ABG_SLEV(FD) |
| Collins3 | fvc | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | fvc | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | fvc | MC and MD | MALE | 5 | 18 | HSU_CAUC(MD and MC) |
| Collins3 | fvc | FC and FD | FEMALE | 5 | 18 | HSU_CAUC(FD and FC) |
| Collins3 | fev5 | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | fev5 | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | fev1 | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | fev1 | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | fev1 | MC and MD | MALE | 5 | 18 | HSU_CAUC(MD and MC) |
| Collins3 | fev1 | FC and FD | FEMALE | 5 | 18 | HSU_CAUC(FD and FC) |
| Collins3 | fev3 | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | fev3 | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | fef2575 | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | fef2575 | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | fef2575 | MC and MD | MALE | 5 | 18 | HSU_CAUC(MD and MC) |
| Collins3 | fef2575 | FC and FD | FEMALE | 5 | 18 | HSU_CAUC(FD and FC) |
| Collins3 | fefmax | MC and MD | MALE | 5 | 18 | HSU_CAUC(MD and MC) |
| Collins3 | fefmax | FC and FD | FEMALE | 5 | 18 | HSU_CAUC(FD and FC) |
| Collins3 | fev1_fvc | FC and FD | FEMALE | 5 | 18 | COLLINS(Everyone) |
| Collins3 | fev1_fvc | MC and MD | MALE | 5 | 18 | COLLINS(Everyone) |
| Collins3 | fev1_fvc | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | fev1_fvc | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | fev3_fvc | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | fev3_fvc | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | mvv | MA | MALE | 19 | 99 | KORY(MA) |
| Collins3 | mvv | FA | FEMALE | 19 | 99 | LINDAL(FA) |
| Collins3 | vc | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | vc | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | rv | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | rv | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | frc | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | frc | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | erv | FA | FEMALE | 19 | 99 | COLLINS(Everyone) |
| Collins3 | erv | MA | MALE | 19 | 99 | COLLINS(Everyone) |
| Collins3 | tlc | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |

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|---|---|---|---|---|---|---|
| Collins3 | tlc | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | ic | FA | FEMALE | 19 | 99 | COLLINS(Everyone) |
| Collins3 | ic | MA | MALE | 19 | 99 | COLLINS(Everyone) |
| Collins3 | rv_tlc | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | rv_tlc | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | dco | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | dco | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | dsb | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | dsb | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins3 | va | FA | FEMALE | 19 | 99 | COLLINS(Everyone) |
| Collins3 | va | MA | MALE | 19 | 99 | COLLINS(Everyone) |
| Collins3 | d_va | FA | FEMALE | 19 | 99 | CRAPOCI(FA) |
| Collins3 | d_va | MA | MALE | 19 | 99 | CRAPOCI(MA) |
| Collins4 | fvc | FC and FD | FEMALE | 6 | 18 | POLGAR79(FD and FC) |
| Collins4 | fvc | MC and MD | MALE | 6 | 18 | POLGAR79(MD and MC) |
| Collins4 | fev1 | FC | FEMALE | 6 | 11 | POLGAR71(Children and Teens) |
| Collins4 | fef2575 | FC | FEMALE | 6 | 11 | POLGAR79(Children and Teens) |
| Collins4 | fefmax | FC and FD | FEMALE | 6 | 18 | POLGAR79(FD and FC) |
| Collins4 | fefmax | MC and MD | MALE | 6 | 18 | POLGAR79(MD and MC) |
| Collins4 | fev1_fvc | FC and FD | FEMALE | 6 | 18 | COLLINS(Everyone) |
| Collins4 | fev1_fvc | MC and MD | MALE | 6 | 18 | COLLINS(Everyone) |
| Collins4 | fifmax | FC and FD | FEMALE | 6 | 18 | POLGAR71(Children and Teens) |
| Collins4 | fifmax | MC and MD | MALE | 6 | 18 | POLGAR71(Children and Teens) |
| Collins4 | mvv | MC and MD | MALE | 6 | 18 | POLGAR71(Children and Teens) |
| Collins4 | mvv | FC and FD | FEMALE | 6 | 18 | POLGAR71(Children and Teens) |
| Collins4 | vc | FC and FD | FEMALE | 6 | 18 | POLGAR79(FD and FC) |
| Collins4 | vc | MC and MD | MALE | 6 | 18 | POLGAR79(MD and MC) |
| Collins4 | rv | FC and FD | FEMALE | 6 | 18 | POLGAR79(Children and Teens) |
| Collins4 | rv | MC and MD | MALE | 6 | 18 | POLGAR79(Children and Teens) |
| Collins4 | frc | FC and FD | FEMALE | 6 | 18 | POLGAR79(FD and FC) |
| Collins4 | frc | MC and MD | MALE | 6 | 18 | POLGAR79(MD and MC) |
| Collins4 | erv | FC and FD | FEMALE | 6 | 18 | COLLINS(Everyone) |
| Collins4 | erv | MC and MD | MALE | 6 | 18 | COLLINS(Everyone) |
| Collins4 | tlc | FC and FD | FEMALE | 6 | 18 | POLGAR79(FD and FC) |
| Collins4 | tlc | MC and | MALE | 6 | 18 | POLGAR79(MD and MC) |

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|---|---|---|---|---|---|---|
| | | MD | | | | |
| Collins4 | ic | FC and FD | FEMALE | 6 | 18 | COLLINS(Everyone) |
| Collins4 | ic | MC and MD | MALE | 6 | 18 | COLLINS(Everyone) |
| Collins4 | rv_tlc | FC and FD | FEMALE | 6 | 18 | COLLINS(Everyone) |
| Collins4 | rv_tlc | MC and MD | MALE | 6 | 18 | COLLINS(Everyone) |
| Collins4 | dco | FC and FD | FEMALE | 6 | 18 | KNUDSON(FD and FC) |
| Collins4 | dco | MC and MD | MALE | 6 | 18 | KNUDSON(MD and MC) |
| Collins4 | dsb | FC and FD | FEMALE | 6 | 18 | KNUDSON(FD and FC) |
| Collins4 | dsb | MC and MD | MALE | 6 | 18 | KNUDSON(MD and MC) |
| Collins4 | va | FC and FD | FEMALE | 6 | 18 | KNUDSON(FD and FC) |
| Collins4 | va | MC and MD | MALE | 6 | 18 | KNUDSON(MD and MC) |
| Collins4 | d_va | FC and FD | FEMALE | 6 | 18 | KNUDSON(FD and FC) |
| Collins4 | d_va | MC and MD | MALE | 6 | 18 | KNUDSON(MD and MC) |
| Collins4 | raw | FC and FD | FEMALE | 6 | 18 | WENG_LEV(Children and Teens) |
| Collins4 | raw | MC and MD | MALE | 6 | 18 | WENG_LEV(Children and Teens) |
| Collins4 | hco3 | FC | FEMALE | 6 | 11 | ABG_SLEV(FC) |
| Collins4 | hco3 | MD | MALE | 12 | 18 | ABG_SLEV(MD) |
| Collins4 | hco3 | MC | MALE | 6 | 11 | ABG_SLEV(MC) |
| Collins4 | hco3 | FD | FEMALE | 12 | 18 | ABG_SLEV(FD) |
| Crapo CI | fvc | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | fvc | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | fev5 | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | fev5 | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | fev1 | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | fev1 | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | fev3 | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | fev3 | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | fef2575 | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | fef2575 | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | fev1_fvc | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | fev1_fvc | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | fev3_fvc | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | fev3_fvc | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | mvv | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | mvv | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | vc | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | vc | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | rv | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | rv | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | frc | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | frc | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | tlc | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |

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|---|---|---|---|---|---|---|
| Crapo CI | tlc | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | rv_tlc | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | rv_tlc | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | dco | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | dco | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | dsb | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | dsb | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| Crapo CI | d_va | FA | FEMALE | 18 | 99 | CRAPOCI(FA) |
| Crapo CI | d_va | MA | MALE | 18 | 99 | CRAPOCI(MA) |
| European | fvc | Females | FEMALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | fvc | Males | MALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | fvc | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | fvc | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |
| European | fev1 | Females | FEMALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | fev1 | Males | MALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | fev1 | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | fev1 | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |
| European | fefmax | Females | FEMALE | 20 | 70 | EUROPEAN(Female Adult) |
| European | fefmax | Males | MALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | fefmax | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | fefmax | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |
| European | fef50 | Females | FEMALE | 20 | 70 | EUROPEAN(Female Adult) |
| European | fef50 | Males | MALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | fef50 | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | fef50 | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |
| European | fef75 | Females | FEMALE | 20 | 70 | EUROPEAN(Female Adult) |
| European | fef75 | Males | MALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | fef75 | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | fef75 | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |
| European | fev1_fvc | Females | FEMALE | 20 | 70 | EUROPEAN(Female Adult) |
| European | fev1_fvc | Males | MALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | fev1_fvc | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | fev1_fvc | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |
| European | fifmax | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | fifmax | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |
| European | rv | Females | FEMALE | 20 | 70 | EUROPEAN(Female Adult) |
| European | rv | Males | MALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | rv | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | rv | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |

| | | | | | | |
|---|---|---|---|---|---|---|
| European | frc | Females | FEMALE | 20 | 70 | EUROPEAN(Female Adult) |
| European | frc | Males | MALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | frc | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | frc | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |
| European | tlc | Females | FEMALE | 20 | 70 | EUROPEAN(Female Adult) |
| European | tlc | Males | MALE | 20 | 70 | EUROPEAN(Female Adult) |
| European | tlc | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | tlc | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | dco | Females | FEMALE | 20 | 70 | EUROPEAN(Female Adult) |
| European | dco | Males | MALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | dco | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | dco | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |
| European | va | Females | FEMALE | 20 | 70 | EUROPEAN(Female Adult) |
| European | va | Males | MALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | va | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | va | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |
| European | d_va | Females | FEMALE | 20 | 70 | EUROPEAN(Female Adult) |
| European | d_va | Males | MALE | 20 | 70 | EUROPEAN(Male Adult) |
| European | d_va | Females (4 - 19) | FEMALE | 4 | 19 | EUROPEAN(Females (4 - 19)) |
| European | d_va | Males (4 - 19) | MALE | 4 | 19 | EUROPEAN(Males (4 - 19)) |
| NHANES3 - AFRICAN-AM | fvc | Males ( 20 – 80) | MALE | 20 | 80 | NHANES3 - AFRICAN-AM(Male (20 - 80)) |
| NHANES3 - AFRICAN-AM | fvc | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - AFRICAN-AM(Male (8 - 19)) |
| NHANES3 - AFRICAN-AM | fvc | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - AFRICAN-AM(Female (8 - 17)) |
| NHANES3 - AFRICAN-AM | fvc | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - AFRICAN-AM(Female (18 - 80)) |
| NHANES3 - AFRICAN-AM | fev1 | Males ( 20 – 80) | MALE | 20 | 80 | NHANES3 - AFRICAN-AM(Male (20 - 80)) |
| NHANES3 - AFRICAN-AM | fev1 | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - AFRICAN-AM(Male (8 - 19)) |
| NHANES3 - AFRICAN-AM | fev1 | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - AFRICAN-AM(Female (8 - 17)) |
| NHANES3 - AFRICAN-AM | fev1 | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - AFRICAN-AM(Female (18 - 80)) |
| NHANES3 - AFRICAN-AM | fev6 | Males ( 20 – 80) | MALE | 20 | 80 | NHANES3 - AFRICAN-AM(Male (20 - 80)) |
| NHANES3 - AFRICAN-AM | fev6 | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - AFRICAN-AM(Male (8 - 19)) |
| NHANES3 - AFRICAN-AM | fev6 | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - AFRICAN-AM(Female (8 - 17)) |
| NHANES3 - AFRICAN-AM | fev6 | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - AFRICAN-AM(Female (18 - 80)) |
| NHANES3 - AFRICAN-AM | fef2575 | Males ( 20 – 80) | MALE | 20 | 80 | NHANES3 - AFRICAN-AM(Male (20 - 80)) |

| | | | | | | |
|---|---|---|---|---|---|---|
| NHANES3 - AFRICAN-AM | fef2575 | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - AFRICAN-AM(Male (8 - 19)) |
| NHANES3 - AFRICAN-AM | fef2575 | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - AFRICAN-AM(Female (8 - 17)) |
| NHANES3 - AFRICAN-AM | fef2575 | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - AFRICAN-AM(Female (18 - 80)) |
| NHANES3 - AFRICAN-AM | fefmax | Males ( 20 – 80) | MALE | 20 | 80 | NHANES3 - AFRICAN-AM(Male (20 - 80)) |
| NHANES3 - AFRICAN-AM | fefmax | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - AFRICAN-AM(Male (8 - 19)) |
| NHANES3 - AFRICAN-AM | fefmax | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - AFRICAN-AM(Female (8 - 17)) |
| NHANES3 - AFRICAN-AM | fefmax | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - AFRICAN-AM(Female (18 - 80)) |
| NHANES3 - AFRICAN-AM | fev1_fvc | Females (8 - 80) | FEMALE | 8 | 80 | NHANES3 - AFRICAN-AM(Female (8 - 80)) |
| NHANES3 - AFRICAN-AM | fev1_fvc | Males (8 - 80) | MALE | 8 | 80 | NHANES3 - AFRICAN-AM(Male (8 - 80)) |
| NHANES3 - AFRICAN-AM | fev1_fev6 | Females (8 - 80) | FEMALE | 8 | 80 | NHANES3 - AFRICAN-AM(Female (8 - 80)) |
| NHANES3 - AFRICAN-AM | fev1_fev6 | Males (8 - 80) | MALE | 8 | 80 | NHANES3 - AFRICAN-AM(Male (8 - 80)) |
| NHANES3 - CAUCASIAN | fvc | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - CAUCASIAN(Female (18 - 80)) |
| NHANES3 - CAUCASIAN | fvc | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - CAUCASIAN(Male (8 - 19)) |
| NHANES3 - CAUCASIAN | fvc | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - CAUCASIAN(Female (8 - 17)) |
| NHANES3 - CAUCASIAN | fvc | Males (20 - 80) | MALE | 20 | 80 | NHANES3 - CAUCASIAN(Male (20 - 80)) |
| NHANES3 - CAUCASIAN | fev1 | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - CAUCASIAN(Female (18 - 80)) |
| NHANES3 - CAUCASIAN | fev1 | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - CAUCASIAN(Male (8 - 19)) |
| NHANES3 - CAUCASIAN | fev1 | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - CAUCASIAN(Male (20 - 80)) |
| NHANES3 - CAUCASIAN | fev1 | Males (20 - 80) | MALE | 20 | 80 | NHANES3 - CAUCASIAN(Male (20 - 80)) |
| NHANES3 - CAUCASIAN | fev6 | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - CAUCASIAN(Female (18 - 80)) |
| NHANES3 - CAUCASIAN | fev6 | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - CAUCASIAN(Male (8 - 19)) |
| NHANES3 - CAUCASIAN | fev6 | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - CAUCASIAN(Female (8 - 17)) |
| NHANES3 - CAUCASIAN | fev6 | Males (20 - 80) | MALE | 20 | 80 | NHANES3 - CAUCASIAN(Male (20 - 80)) |
| NHANES3 - CAUCASIAN | fef2575 | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - CAUCASIAN(Female (18 - 80)) |
| NHANES3 - | fef2575 | Males (8 - | MALE | 8 | 19 | NHANES3 - |

| | | | | | | |
|---|---|---|---|---|---|---|
| CAUCASIAN | | 19) | | | | CAUCASIAN(Male (8 - 19)) |
| NHANES3 - CAUCASIAN | fef2575 | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - CAUCASIAN(Female (8 - 17)) |
| NHANES3 - CAUCASIAN | fef2575 | Males (20 - 80) | MALE | 20 | 80 | NHANES3 - CAUCASIAN(Male (20 - 80)) |
| NHANES3 - CAUCASIAN | fefmax | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - CAUCASIAN(Female (18 - 80)) |
| NHANES3 - CAUCASIAN | fefmax | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - CAUCASIAN(Male (8 - 19)) |
| NHANES3 - CAUCASIAN | fefmax | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - CAUCASIAN(Female (8 - 17)) |
| NHANES3 - CAUCASIAN | fefmax | Males (20 - 80) | MALE | 20 | 80 | NHANES3 - CAUCASIAN(Male (20 - 80)) |
| NHANES3 - CAUCASIAN | fev1_fvc | Females (8 - 80) | FEMALE | 8 | 80 | NHANES3 - CAUCASIAN(Female (8 - 80)) |
| NHANES3 - CAUCASIAN | fev1_fvc | Males (8 - 80) | MALE | 8 | 80 | NHANES3 - CAUCASIAN(Male (8 - 80)) |
| NHANES3 - CAUCASIAN | fev1_fev6 | Females (8 - 80) | FEMALE | 8 | 80 | NHANES3 - CAUCASIAN(Female (8 - 80)) |
| NHANES3 - CAUCASIAN | fev1_fev6 | Males (8 - 80) | MALE | 8 | 80 | NHANES3 - CAUCASIAN(Male (8 - 80)) |
| NHANES3 - MEX-AMER | fvc | Males ( 20 - 80) | MALE | 20 | 80 | NHANES3 - MEX-AMER(Male (20 - 80)) |
| NHANES3 - MEX-AMER | fvc | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - MEX-AMER(Female (8 - 17)) |
| NHANES3 - MEX-AMER | fvc | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - MEX-AMER(Female (18 - 80)) |
| NHANES3 - MEX-AMER | fvc | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - MEX-AMER(Male (8 - 19)) |
| NHANES3 - MEX-AMER | fev1 | Males ( 20 - 80) | MALE | 20 | 80 | NHANES3 - MEX-AMER(Male (20 - 80)) |
| NHANES3 - MEX-AMER | fev1 | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - MEX-AMER(Female (8 - 17)) |
| NHANES3 - MEX-AMER | fev1 | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - MEX-AMER(Female (18 - 80)) |
| NHANES3 - MEX-AMER | fev1 | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - MEX-AMER(Male (8 - 19)) |
| NHANES3 - MEX-AMER | fev6 | Males ( 20 - 80) | MALE | 20 | 80 | NHANES3 - MEX-AMER(Male (20 - 80)) |
| NHANES3 - MEX-AMER | fev6 | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - MEX-AMER(Female (8 - 17)) |
| NHANES3 - MEX-AMER | fev6 | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - MEX-AMER(Female (18 - 80)) |
| NHANES3 - MEX-AMER | fev6 | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - MEX-AMER(Male (8 - 19)) |
| NHANES3 - MEX-AMER | fef2575 | Males ( 20 - 80) | MALE | 20 | 80 | NHANES3 - MEX-AMER(Male (20 - 80)) |
| NHANES3 - MEX-AMER | fef2575 | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - MEX-AMER(Female (8 - 17)) |
| NHANES3 - MEX-AMER | fef2575 | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - MEX-AMER(Female (18 - 80)) |

| | | | | | | |
|---|---|---|---|---|---|---|
| NHANES3 - MEX-AMER | fef2575 | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - MEX-AMER(Male (8 - 19)) |
| NHANES3 - MEX-AMER | fefmax | Males ( 20 - 80) | MALE | 20 | 80 | NHANES3 - MEX-AMER(Male (20 - 80)) |
| NHANES3 - MEX-AMER | fefmax | Females (8 - 17) | FEMALE | 8 | 17 | NHANES3 - MEX-AMER(Female (8 - 17)) |
| NHANES3 - MEX-AMER | fefmax | Females (18 - 80) | FEMALE | 18 | 80 | NHANES3 - MEX-AMER(Female (18 - 80)) |
| NHANES3 - MEX-AMER | fefmax | Males (8 - 19) | MALE | 8 | 19 | NHANES3 - MEX-AMER(Male (8 - 19)) |
| NHANES3 - MEX-AMER | fev1_fvc | Females (8 - 80) | FEMALE | 8 | 80 | NHANES3 - MEX-AMER(Female (8 - 80)) |
| NHANES3 - MEX-AMER | fev1_fvc | Males (8 - 80) | MALE | 8 | 80 | NHANES3 - MEX-AMER(Male (8 - 80)) |
| NHANES3 - MEX-AMER | fev1_fev6 | Females (8 - 80) | FEMALE | 8 | 80 | NHANES3 - MEX-AMER(Female (8 - 80)) |
| NHANES3 - MEX-AMER | fev1_fev6 | Males (8 - 80) | MALE | 8 | 80 | NHANES3 - MEX-AMER(Male (8 - 80)) |

# APPENDIX D – LOGIC OF THE EXTENDED ELLIS INTERPRETATION PROGRAM

On the following pages the logic of the Extended Ellis Interpretation Program is illustrated. These pages have two page numbers on them:

- The page numbers that follow the PLUS/2000 manual sequence.
- The Flow Chart page numbers. Refer to these when looking for a page number called out by the Flow Chart.

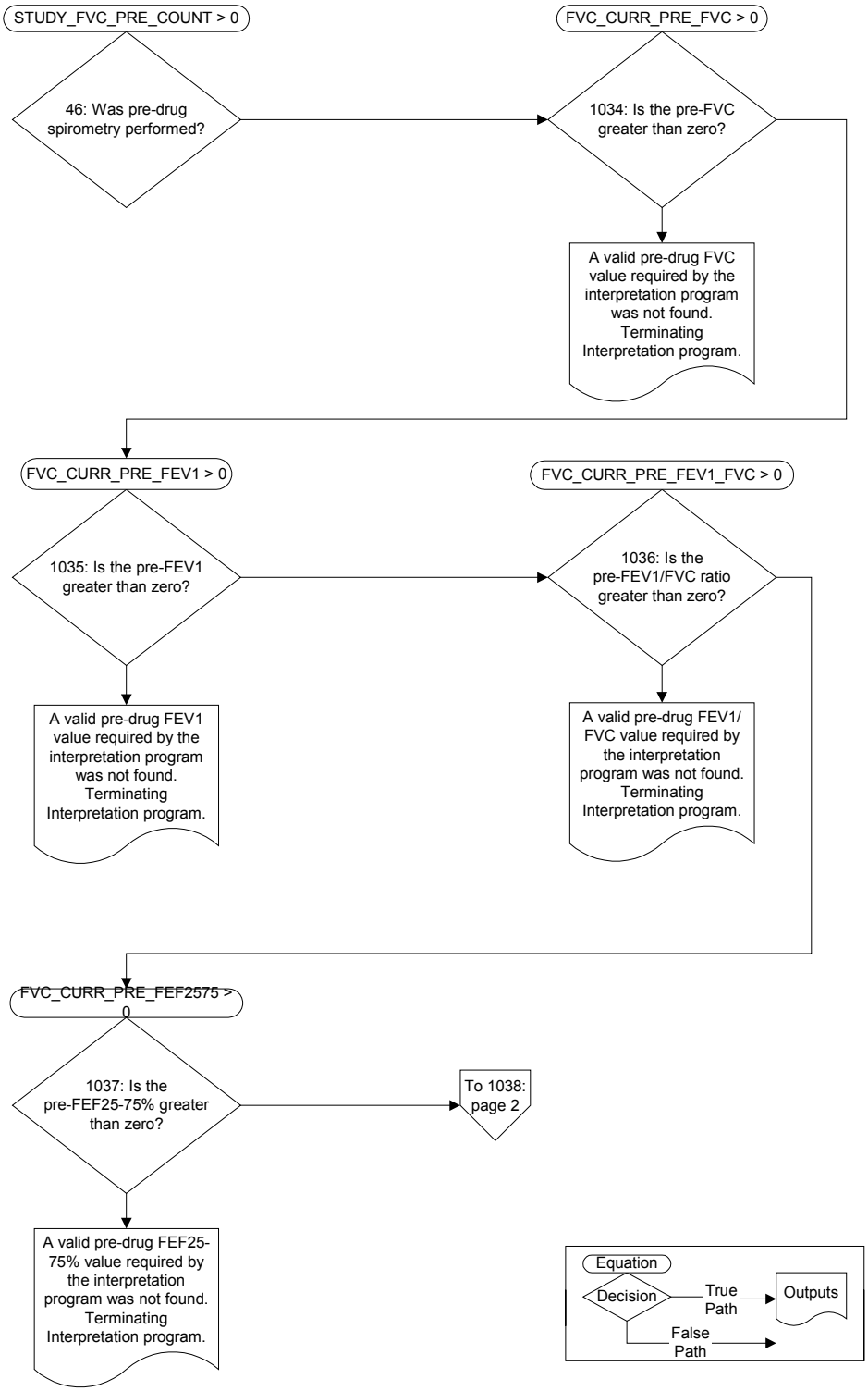
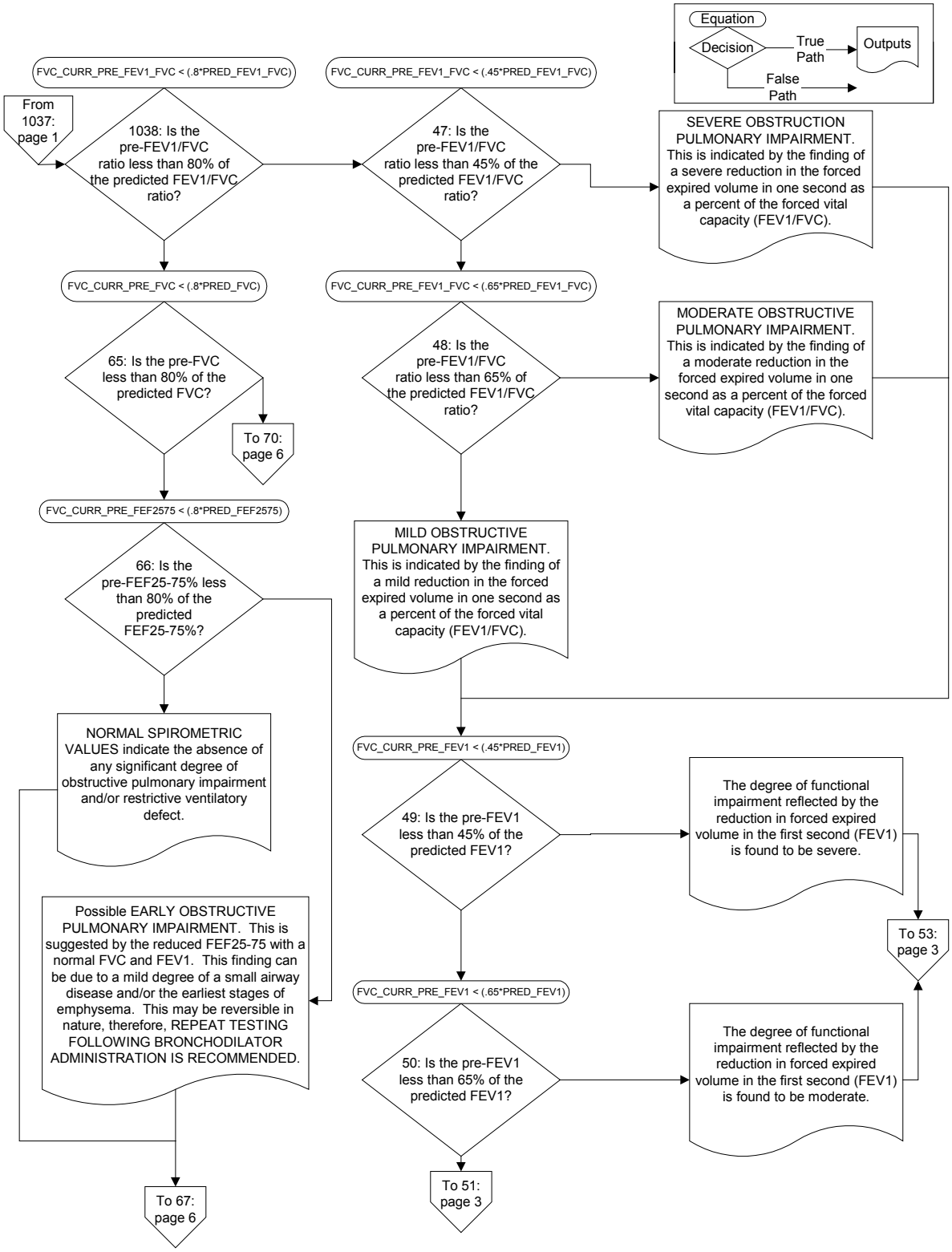
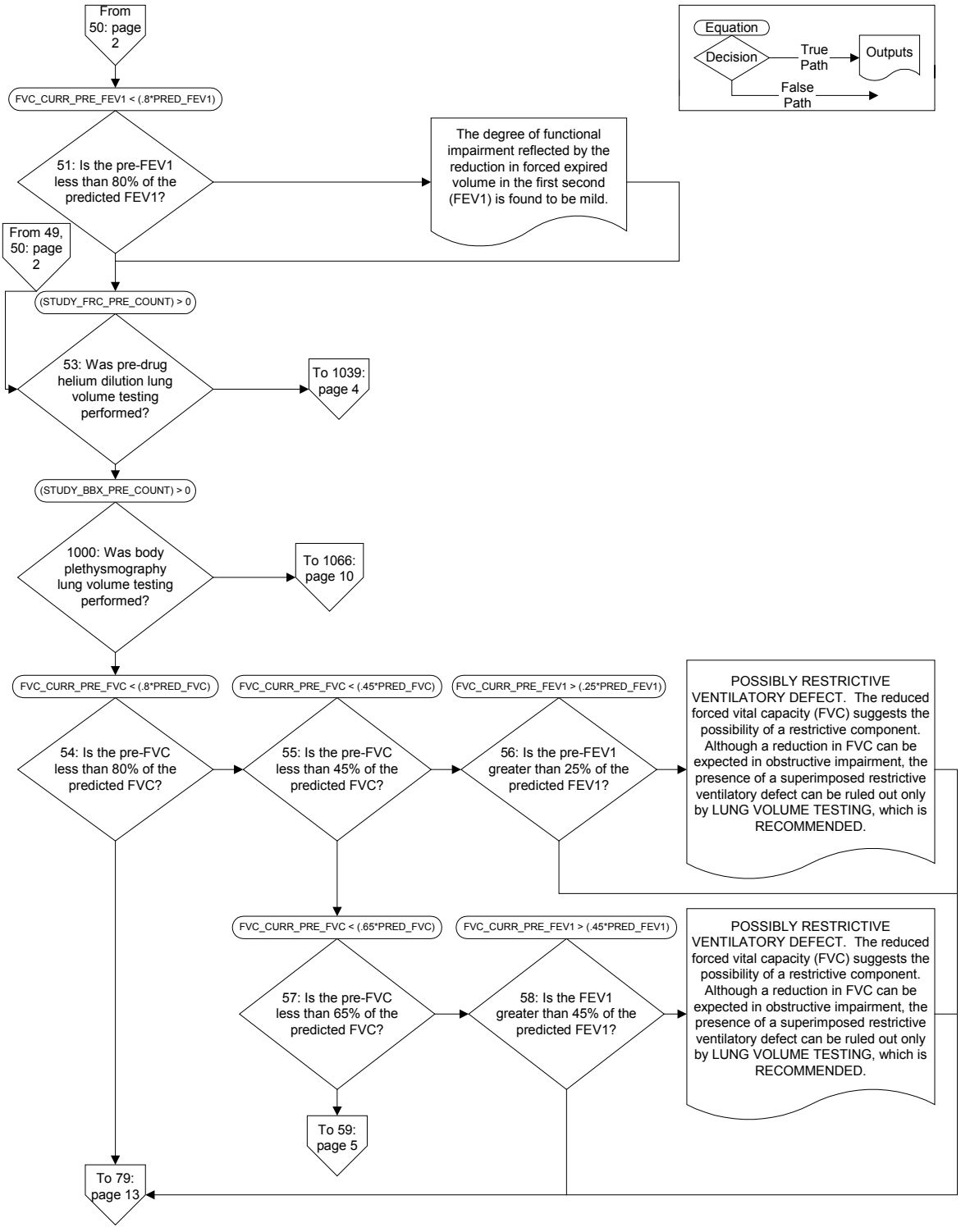

STUDY_FVC_PRE_COUNT > 0
46: Was pre-drug spirometry performed?
FVC_CURR_PRE_FVC > 0
1034: Is the pre-FVC greater than zero?
A valid pre-drug FVC value required by the interpretation program was not found. Terminating Interpretation program.
FVC_CURR_PRE_FEV1 > 0
1035: Is the pre-FEV1 greater than zero?
FVC_CURR_PRE_FEV1_FVC > 0
1036: Is the pre-FEV1/FVC ratio greater than zero?
A valid pre-drug FEV1 value required by the interpretation program was not found. Terminating Interpretation program.
A valid pre-drug FEV1/ FVC value required by the interpretation program was not found. Terminating Interpretation program.
FVC_CURR_PRE_FEF2575 > 0
1037: Is the pre-FEF25-75% greater than zero?
To 1038: page 2
A valid pre-drug FEF25-75% value required by the interpretation program was not found. Terminating Interpretation program.
Equation
Decision
True Path
Outputs
False Path

Figure D-1. Flow Chart of the Extended Ellis Interpretation Program

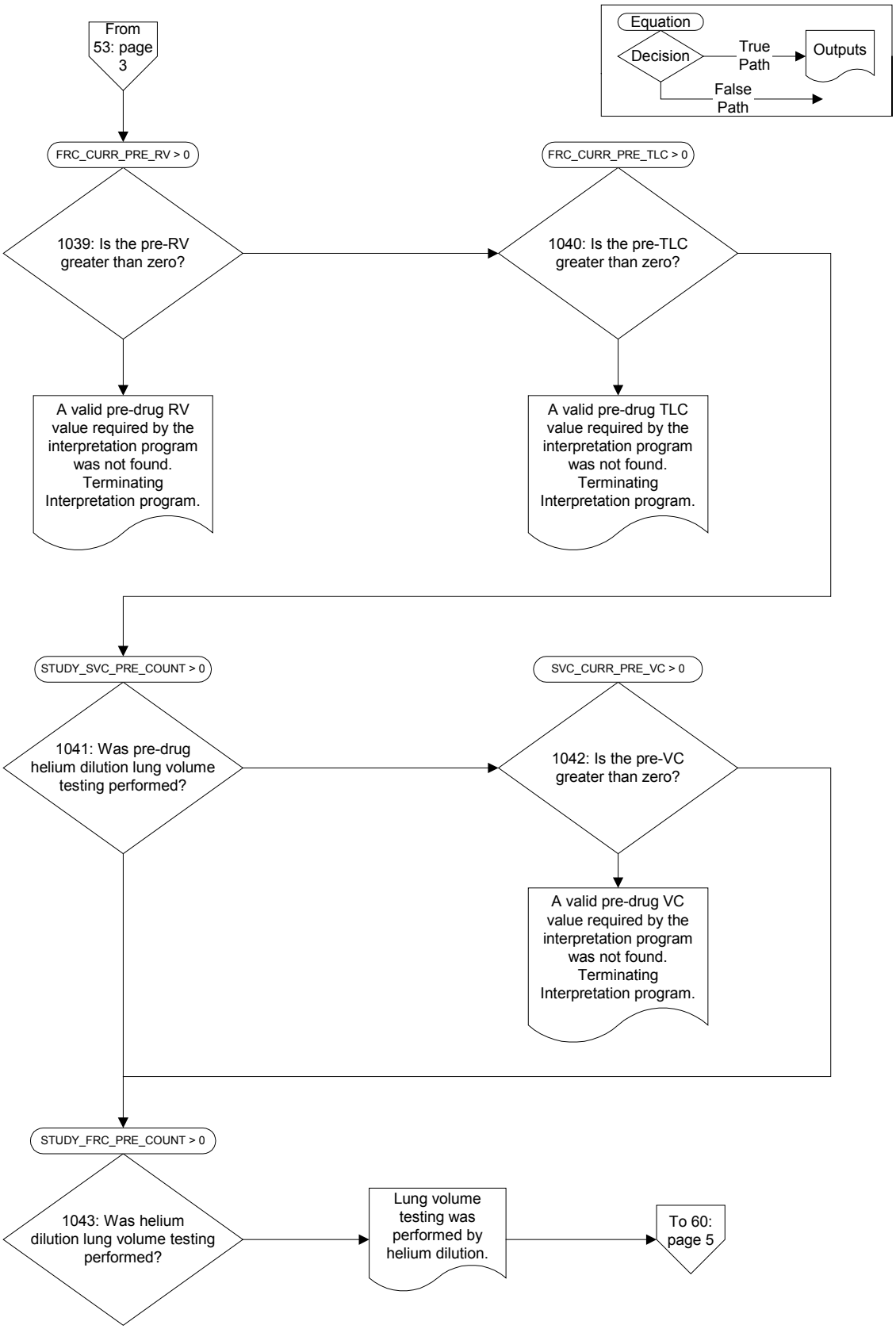
Flow Chart page 1


Equation
Decision
True Path
Outputs
False Path
FVC_CURR_PRE_FEV1_FVC < (.8*PRED_FEV1_FVC)
FVC_CURR_PRE_FEV1_FVC < (.45*PRED_FEV1_FVC)
From 1037: page 1
1038: Is the pre-FEV1/FVC ratio less than 80% of the predicted FEV1/FVC ratio?
47: Is the pre-FEV1/FVC ratio less than 45% of the predicted FEV1/FVC ratio?
SEVERE OBSTRUCTION PULMONARY IMPAIRMENT. This is indicated by the finding of a severe reduction in the forced expired volume in one second as a percent of the forced vital capacity (FEV1/FVC).
FVC_CURR_PRE_FVC < (.8*PRED_FVC)
FVC_CURR_PRE_FEV1_FVC < (.65*PRED_FEV1_FVC)
65: Is the pre-FVC less than 80% of the predicted FVC?
48: Is the pre-FEV1/FVC ratio less than 65% of the predicted FEV1/FVC ratio?
MODERATE OBSTRUCTIVE PULMONARY IMPAIRMENT. This is indicated by the finding of a moderate reduction in the forced expired volume in one second as a percent of the forced vital capacity (FEV1/FVC).
To 70: page 6
FVC_CURR_PRE_FEF2575 < (.8*PRED_FEF2575)
MILD OBSTRUCTIVE PULMONARY IMPAIRMENT. This is indicated by the finding of a mild reduction in the forced expired volume in one second as a percent of the forced vital capacity (FEV1/FVC).
66: Is the pre-FEF25-75% less than 80% of the predicted FEF25-75%?
NORMAL SPIROMETRIC VALUES indicate the absence of any significant degree of obstructive pulmonary impairment and/or restrictive ventilatory defect.
FVC_CURR_PRE_FEV1 < (.45*PRED_FEV1)
49: Is the pre-FEV1 less than 45% of the predicted FEV1?
The degree of functional impairment reflected by the reduction in forced expired volume in the first second (FEV1) is found to be severe.
To 53: page 3
Possible EARLY OBSTRUCTIVE PULMONARY IMPAIRMENT. This is suggested by the reduced FEF25-75 with a normal FVC and FEV1. This finding can be due to a mild degree of a small airway disease and/or the earliest stages of emphysema. This may be reversible in nature, therefore, REPEAT TESTING FOLLOWING BRONCHODILATOR ADMINISTRATION IS RECOMMENDED.
FVC_CURR_PRE_FEV1 < (.65*PRED_FEV1)
50: Is the pre-FEV1 less than 65% of the predicted FEV1?
The degree of functional impairment reflected by the reduction in forced expired volume in the first second (FEV1) is found to be moderate.
To 67: page 6
To 51: page 3

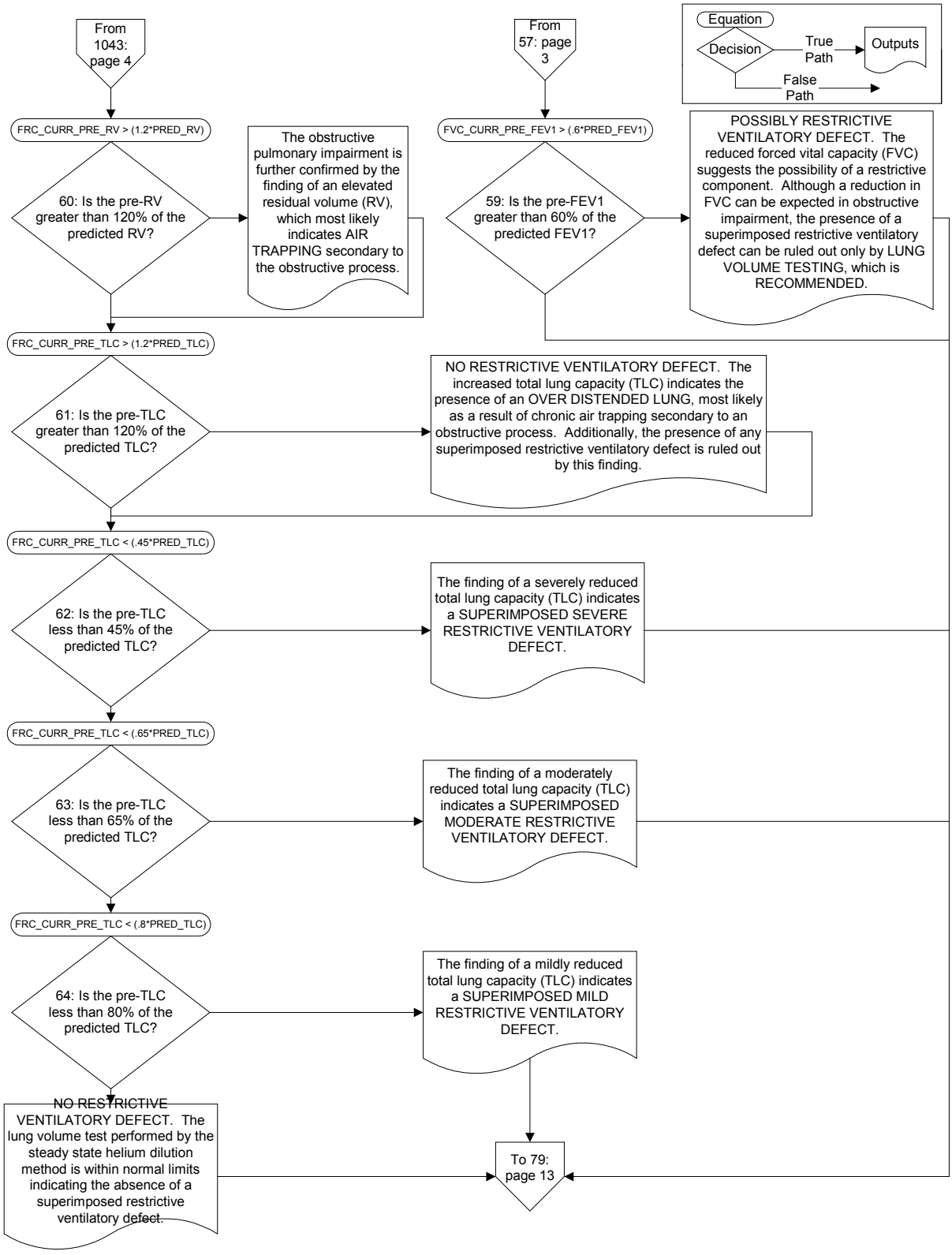
Flow Chart page 2



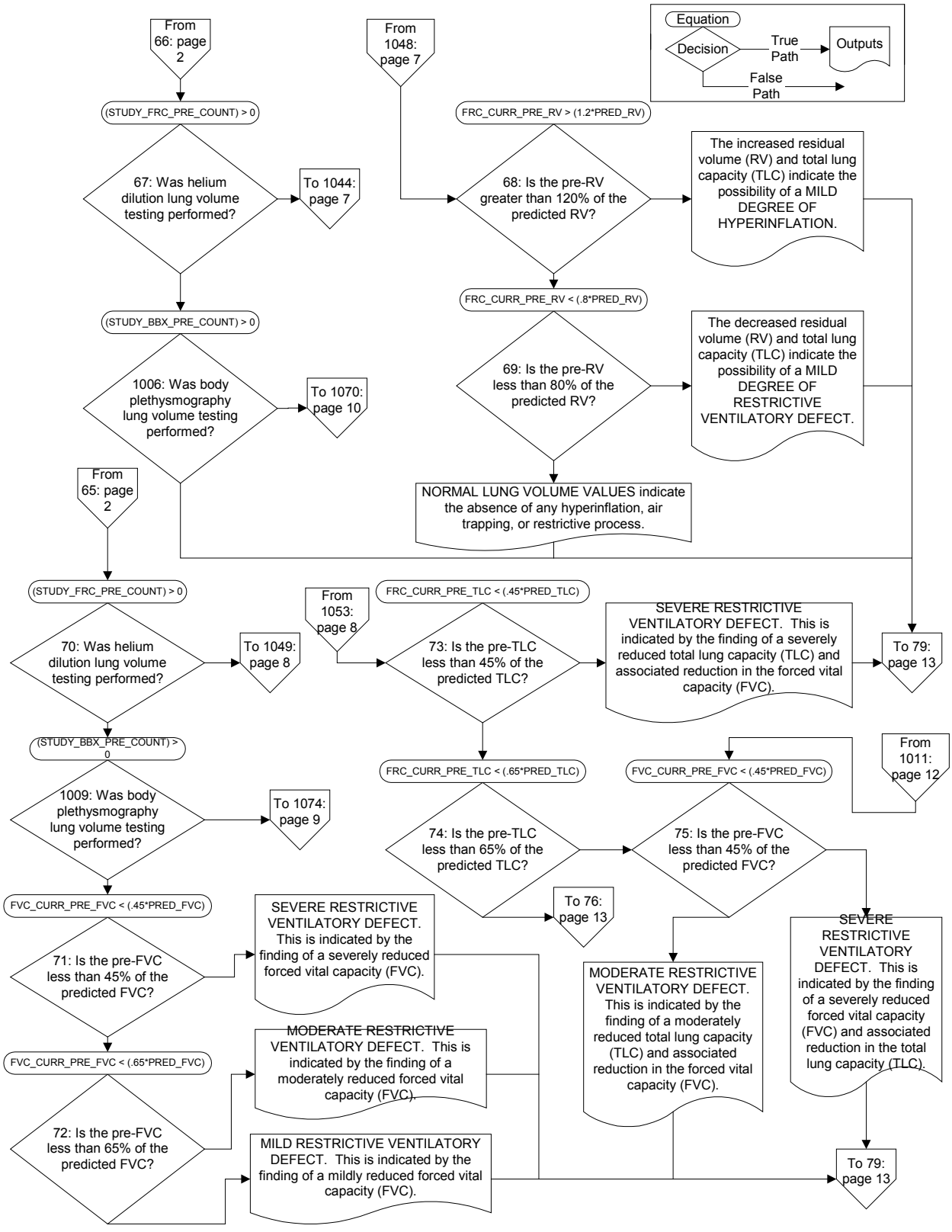

Flow Chart page 3


Equation
Decision
True Path
Outputs
False Path
From 53: page 3
FRC_CURR_PRE_RV > 0
1039: Is the pre-RV greater than zero?
A valid pre-drug RV value required by the interpretation program was not found. Terminating Interpretation program.
FRC_CURR_PRE_TLC > 0
1040: Is the pre-TLC greater than zero?
A valid pre-drug TLC value required by the interpretation program was not found. Terminating Interpretation program.
STUDY_SVC_PRE_COUNT > 0
1041: Was pre-drug helium dilution lung volume testing performed?
SVC_CURR_PRE_VC > 0
1042: Is the pre-VC greater than zero?
A valid pre-drug VC value required by the interpretation program was not found. Terminating Interpretation program.
STUDY_FRC_PRE_COUNT > 0
1043: Was helium dilution lung volume testing performed?
Lung volume testing was performed by helium dilution.
To 60: page 5

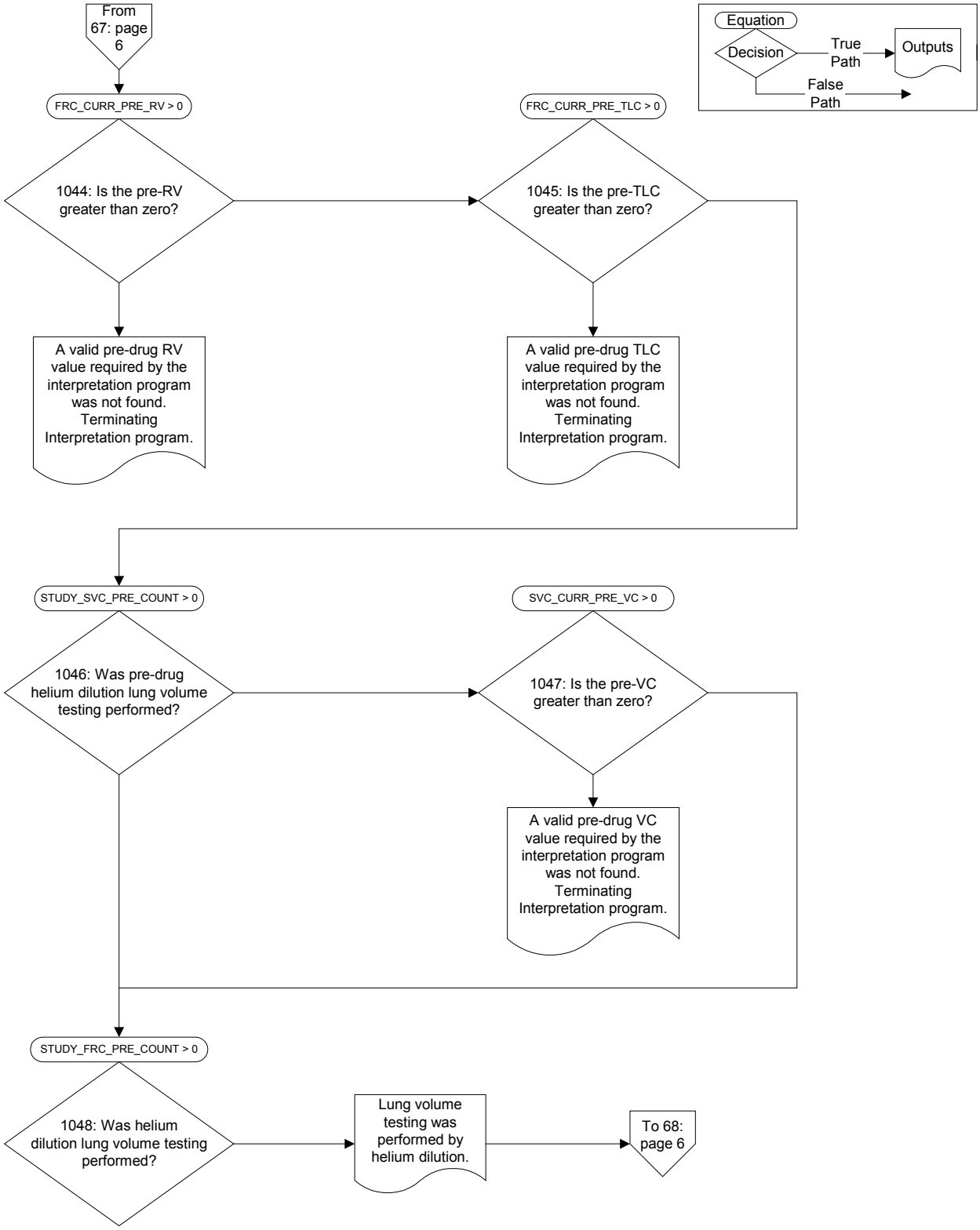
Flow Chart page 4


From 1043: page 4
From 57: page 3
Equation
Decision
True Path
Outputs
False Path
FRC_CURR_PRE_RV > (1.2*PRED_RV)
60: Is the pre-RV greater than 120% of the predicted RV?
The obstructive pulmonary impairment is further confirmed by the finding of an elevated residual volume (RV), which most likely indicates AIR TRAPPING secondary to the obstructive process.
FVC_CURR_PRE_FEV1 > (.6*PRED_FEV1)
59: Is the pre-FEV1 greater than 60% of the predicted FEV1?
POSSIBLY RESTRICTIVE VENTILATORY DEFECT. The reduced forced vital capacity (FVC) suggests the possibility of a restrictive component. Although a reduction in FVC can be expected in obstructive impairment, the presence of a superimposed restrictive ventilatory defect can be ruled out only by LUNG VOLUME TESTING, which is RECOMMENDED.
FRC_CURR_PRE_TLC > (1.2*PRED_TLC)
61: Is the pre-TLC greater than 120% of the predicted TLC?
NO RESTRICTIVE VENTILATORY DEFECT. The increased total lung capacity (TLC) indicates the presence of an OVER DISTENDED LUNG, most likely as a result of chronic air trapping secondary to an obstructive process. Additionally, the presence of any superimposed restrictive ventilatory defect is ruled out by this finding.
FRC_CURR_PRE_TLC < (.45*PRED_TLC)
62: Is the pre-TLC less than 45% of the predicted TLC?
The finding of a severely reduced total lung capacity (TLC) indicates a SUPERIMPOSED SEVERE RESTRICTIVE VENTILATORY DEFECT.
FRC_CURR_PRE_TLC < (.65*PRED_TLC)
63: Is the pre-TLC less than 65% of the predicted TLC?
The finding of a moderately reduced total lung capacity (TLC) indicates a SUPERIMPOSED MODERATE RESTRICTIVE VENTILATORY DEFECT.
FRC_CURR_PRE_TLC < (.8*PRED_TLC)
64: Is the pre-TLC less than 80% of the predicted TLC?
The finding of a mildly reduced total lung capacity (TLC) indicates a SUPERIMPOSED MILD RESTRICTIVE VENTILATORY DEFECT.
NO RESTRICTIVE VENTILATORY DEFECT. The lung volume test performed by the steady state helium dilution method is within normal limits indicating the absence of a superimposed restrictive ventilatory defect.
To 79: page 13

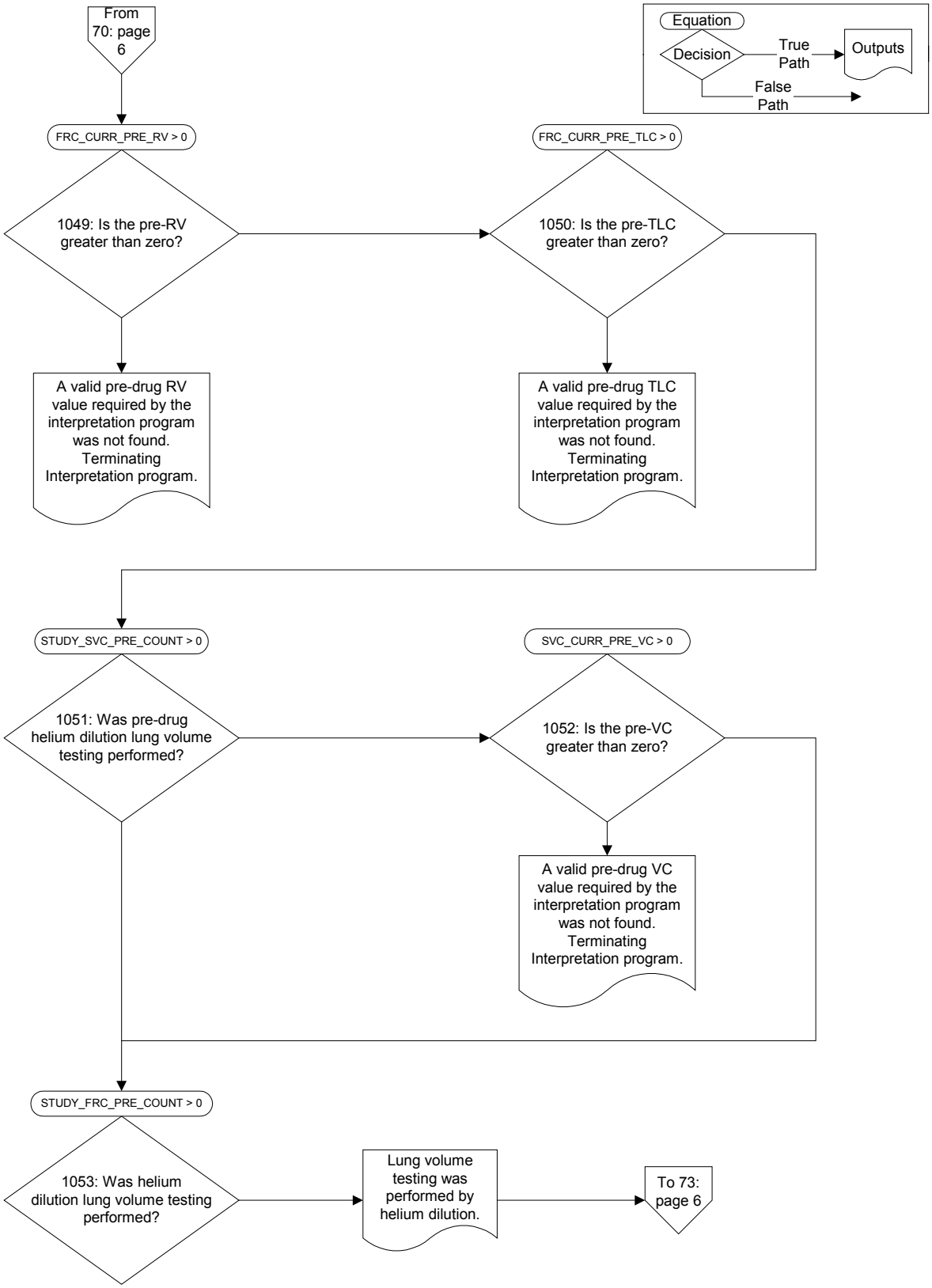
Flow Chart page 5


Equation
Decision
True Path
Outputs
False Path
From 66: page 2
(STUDY_FRC_PRE_COUNT) > 0
67: Was helium dilution lung volume testing performed?
To 1044: page 7
(STUDY_BBX_PRE_COUNT) > 0
1006: Was body plethysmography lung volume testing performed?
To 1070: page 10
From 1048: page 7
FRC_CURR_PRE_RV > (1.2*PRED_RV)
68: Is the pre-RV greater than 120% of the predicted RV?
The increased residual volume (RV) and total lung capacity (TLC) indicate the possibility of a MILD DEGREE OF HYPERINFLATION.
FRC_CURR_PRE_RV < (.8*PRED_RV)
69: Is the pre-RV less than 80% of the predicted RV?
The decreased residual volume (RV) and total lung capacity (TLC) indicate the possibility of a MILD DEGREE OF RESTRICTIVE VENTILATORY DEFECT.
NORMAL LUNG VOLUME VALUES indicate the absence of any hyperinflation, air trapping, or restrictive process.
From 65: page 2
(STUDY_FRC_PRE_COUNT) > 0
70: Was helium dilution lung volume testing performed?
To 1049: page 8
From 1053: page 8
FRC_CURR_PRE_TLC < (.45*PRED_TLC)
73: Is the pre-TLC less than 45% of the predicted TLC?
SEVERE RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a severely reduced total lung capacity (TLC) and associated reduction in the forced vital capacity (FVC).
To 79: page 13
(STUDY_BBX_PRE_COUNT) > 0
1009: Was body plethysmography lung volume testing performed?
To 1074: page 9
FRC_CURR_PRE_TLC < (.65*PRED_TLC)
74: Is the pre-TLC less than 65% of the predicted TLC?
To 76: page 13
FVC_CURR_PRE_FVC < (.45*PRED_FVC)
75: Is the pre-FVC less than 45% of the predicted FVC?
From 1011: page 12
FVC_CURR_PRE_FVC < (.45*PRED_FVC)
71: Is the pre-FVC less than 45% of the predicted FVC?
SEVERE RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a severely reduced forced vital capacity (FVC).
MODERATE RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a moderately reduced total lung capacity (TLC) and associated reduction in the forced vital capacity (FVC).
SEVERE RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a severely reduced forced vital capacity (FVC) and associated reduction in the total lung capacity (TLC).
FVC_CURR_PRE_FVC < (.65*PRED_FVC)
72: Is the pre-FVC less than 65% of the predicted FVC?
MODERATE RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a moderately reduced forced vital capacity (FVC).
MILD RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a mildly reduced forced vital capacity (FVC).
To 79: page 13

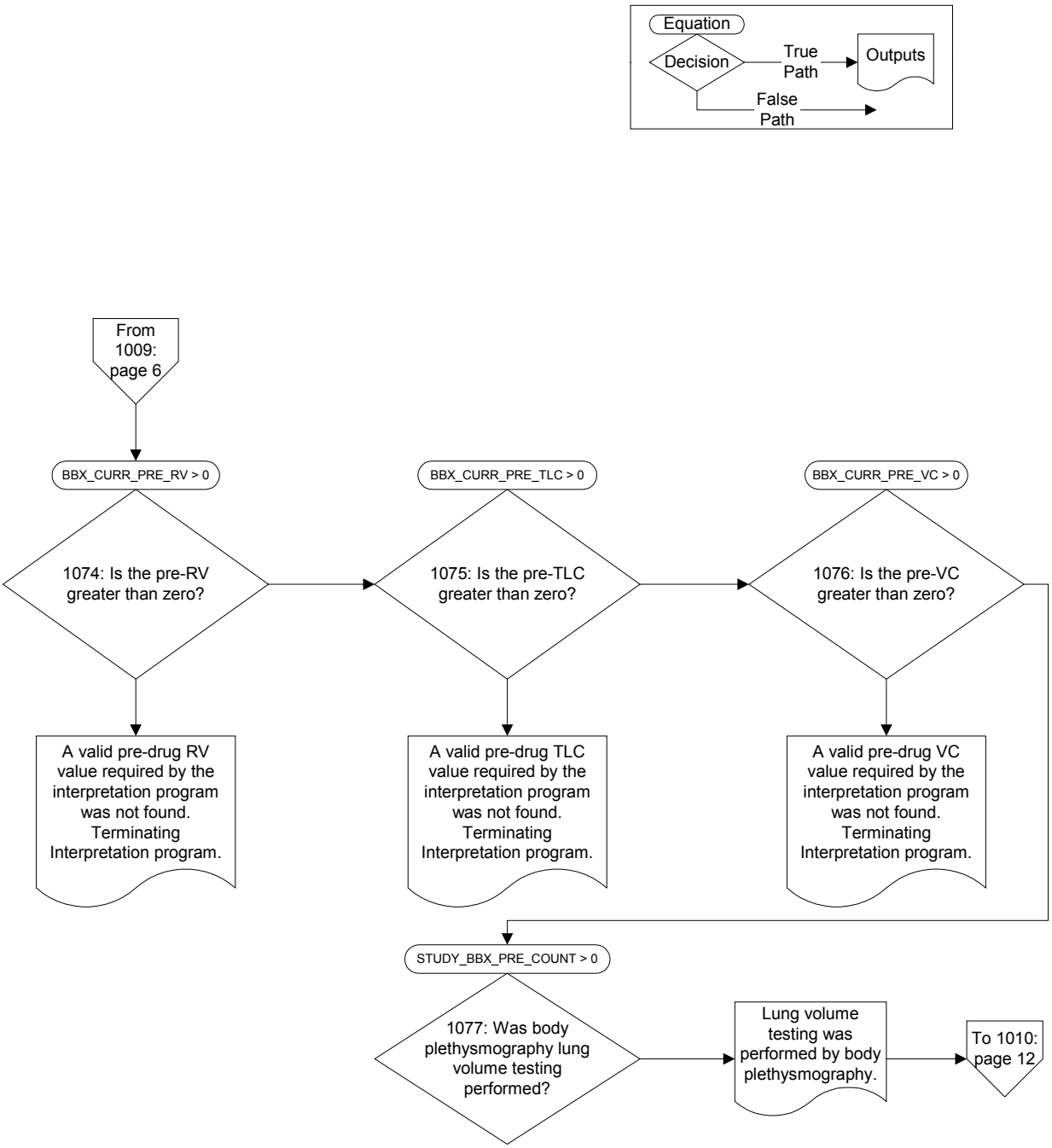
Flow Chart page 6


From 67: page 6
Equation
Decision
True Path
Outputs
False Path
FRC_CURR_PRE_RV > 0
1044: Is the pre-RV greater than zero?
FRC_CURR_PRE_TLC > 0
1045: Is the pre-TLC greater than zero?
A valid pre-drug RV value required by the interpretation program was not found. Terminating Interpretation program.
A valid pre-drug TLC value required by the interpretation program was not found. Terminating Interpretation program.
STUDY_SVC_PRE_COUNT > 0
1046: Was pre-drug helium dilution lung volume testing performed?
SVC_CURR_PRE_VC > 0
1047: Is the pre-VC greater than zero?
A valid pre-drug VC value required by the interpretation program was not found. Terminating Interpretation program.
STUDY_FRC_PRE_COUNT > 0
1048: Was helium dilution lung volume testing performed?
Lung volume testing was performed by helium dilution.
To 68: page 6

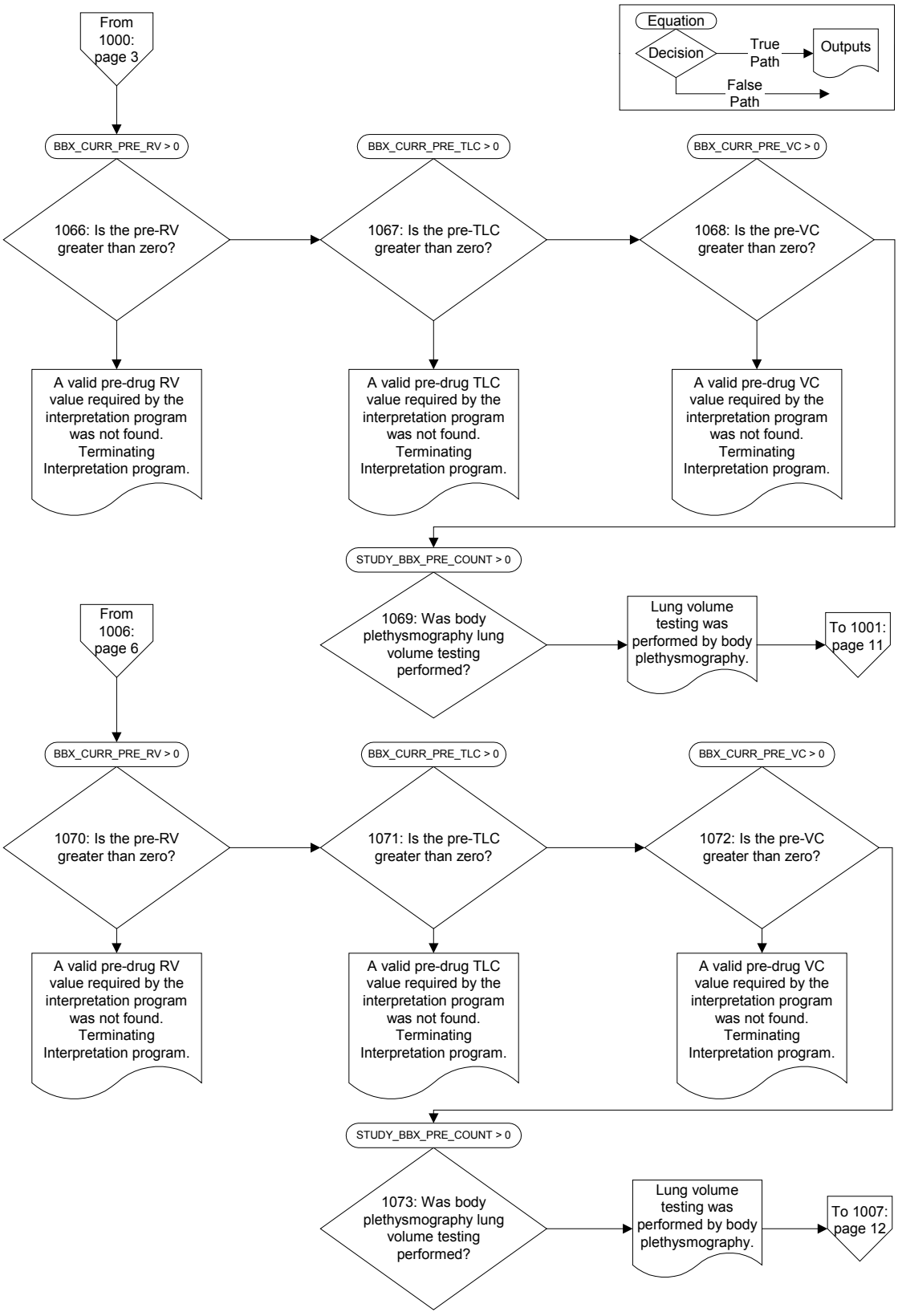
Flow Chart page 7


From 70: page 6
Equation
Decision
True Path
Outputs
False Path
FRC_CURR_PRE_RV > 0
1049: Is the pre-RV greater than zero?
FRC_CURR_PRE_TLC > 0
1050: Is the pre-TLC greater than zero?
A valid pre-drug RV value required by the interpretation program was not found. Terminating Interpretation program.
A valid pre-drug TLC value required by the interpretation program was not found. Terminating Interpretation program.
STUDY_SVC_PRE_COUNT > 0
1051: Was pre-drug helium dilution lung volume testing performed?
SVC_CURR_PRE_VC > 0
1052: Is the pre-VC greater than zero?
A valid pre-drug VC value required by the interpretation program was not found. Terminating Interpretation program.
STUDY_FRC_PRE_COUNT > 0
1053: Was helium dilution lung volume testing performed?
Lung volume testing was performed by helium dilution.
To 73: page 6

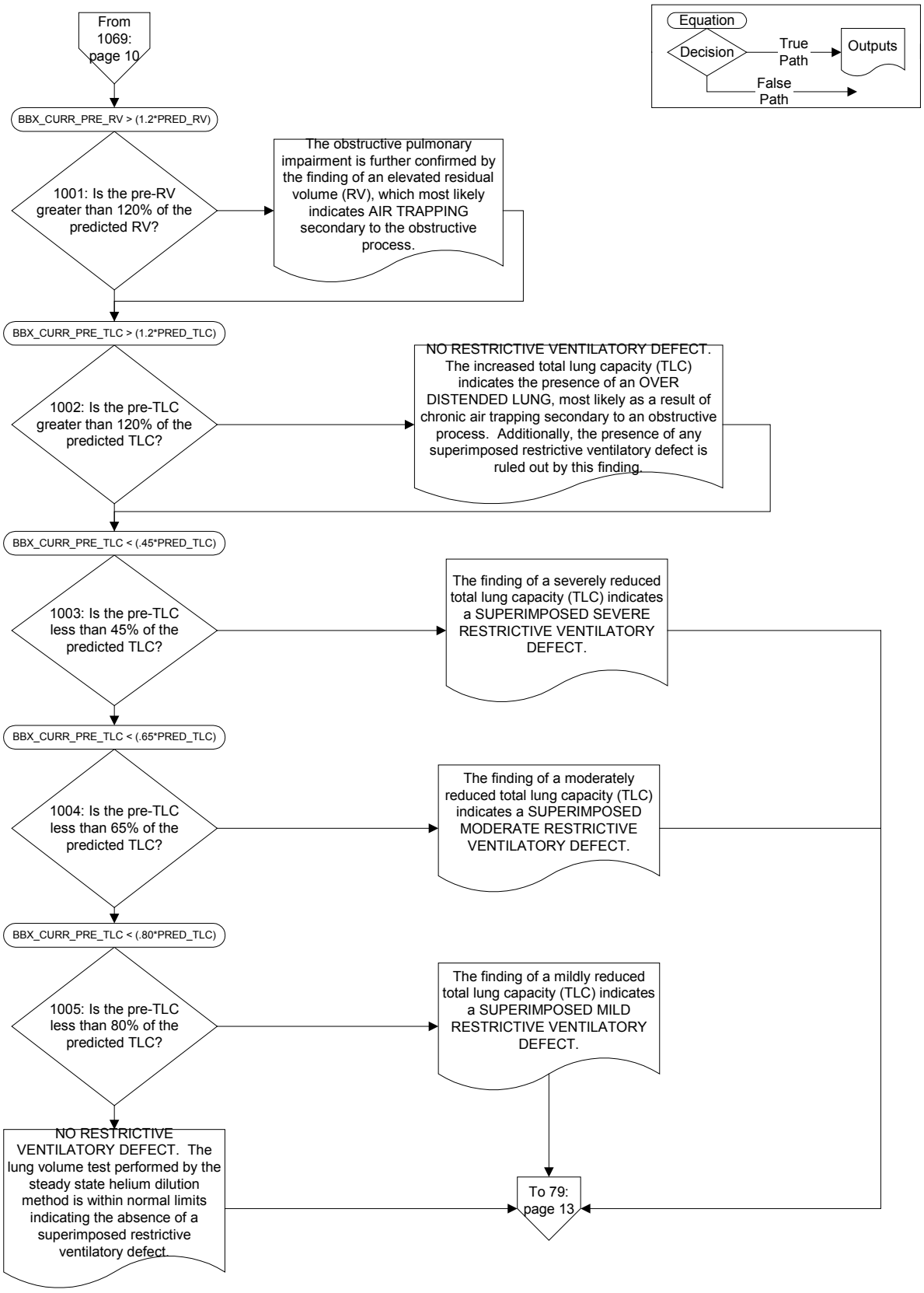
Flow Chart page 8


Equation
Decision
True Path
Outputs
False Path
From 1009: page 6
BBX_CURR_PRE_RV > 0
1074: Is the pre-RV greater than zero?
A valid pre-drug RV value required by the interpretation program was not found. Terminating Interpretation program.
BBX_CURR_PRE_TLC > 0
1075: Is the pre-TLC greater than zero?
A valid pre-drug TLC value required by the interpretation program was not found. Terminating Interpretation program.
BBX_CURR_PRE_VC > 0
1076: Is the pre-VC greater than zero?
A valid pre-drug VC value required by the interpretation program was not found. Terminating Interpretation program.
STUDY_BBX_PRE_COUNT > 0
1077: Was body plethysmography lung volume testing performed?
Lung volume testing was performed by body plethysmography.
To 1010: page 12

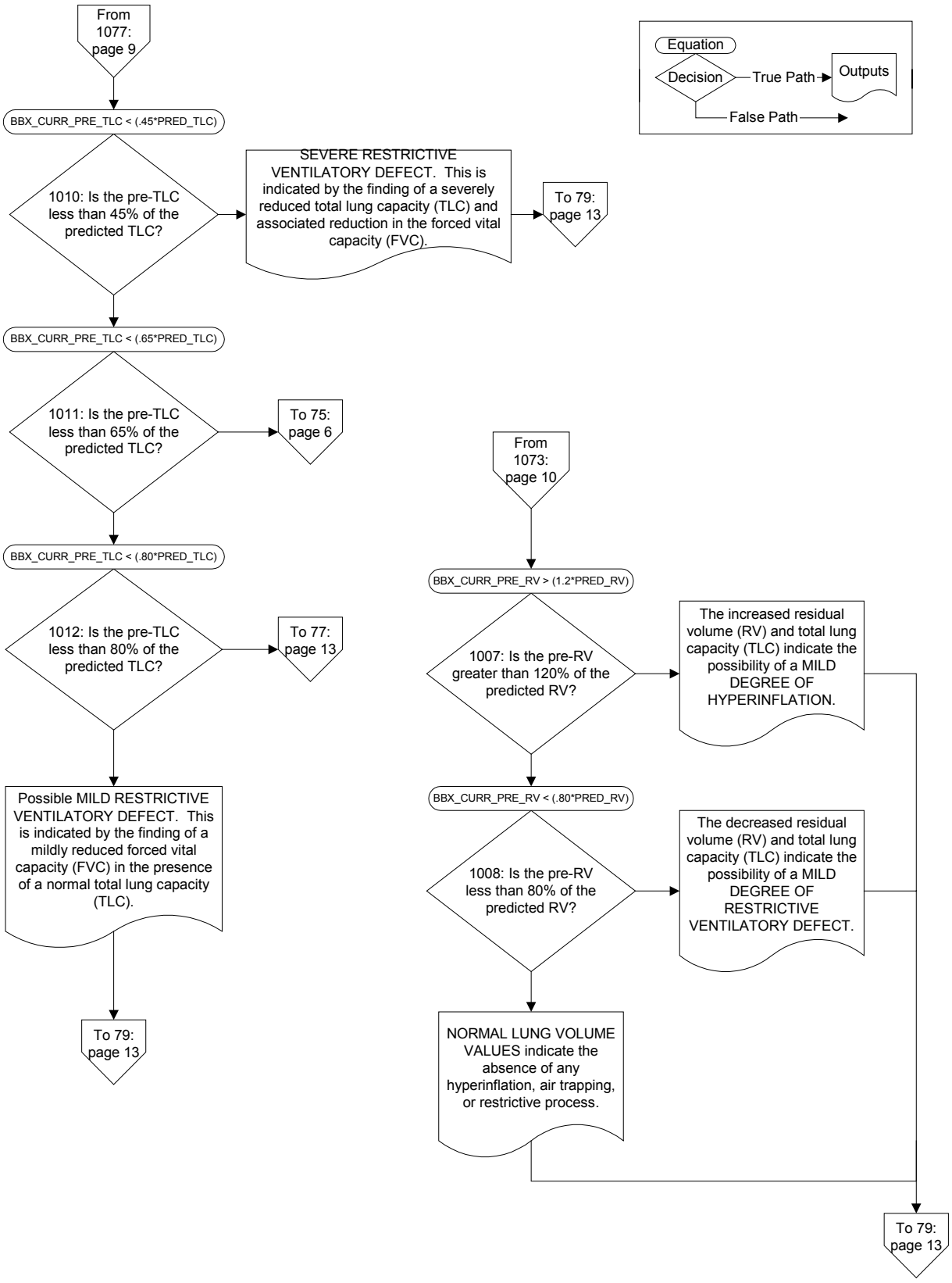
Flow Chart page 9


From 1000: page 3
Equation
Decision
True Path
Outputs
False Path
BBX_CURR_PRE_RV > 0
1066: Is the pre-RV greater than zero?
BBX_CURR_PRE_TLC > 0
1067: Is the pre-TLC greater than zero?
BBX_CURR_PRE_VC > 0
1068: Is the pre-VC greater than zero?
A valid pre-drug RV value required by the interpretation program was not found. Terminating Interpretation program.
A valid pre-drug TLC value required by the interpretation program was not found. Terminating Interpretation program.
A valid pre-drug VC value required by the interpretation program was not found. Terminating Interpretation program.
STUDY_BBX_PRE_COUNT > 0
From 1006: page 6
1069: Was body plethysmography lung volume testing performed?
Lung volume testing was performed by body plethysmography.
To 1001: page 11
BBX_CURR_PRE_RV > 0
1070: Is the pre-RV greater than zero?
BBX_CURR_PRE_TLC > 0
1071: Is the pre-TLC greater than zero?
BBX_CURR_PRE_VC > 0
1072: Is the pre-VC greater than zero?
A valid pre-drug RV value required by the interpretation program was not found. Terminating Interpretation program.
A valid pre-drug TLC value required by the interpretation program was not found. Terminating Interpretation program.
A valid pre-drug VC value required by the interpretation program was not found. Terminating Interpretation program.
STUDY_BBX_PRE_COUNT > 0
1073: Was body plethysmography lung volume testing performed?
Lung volume testing was performed by body plethysmography.
To 1007: page 12

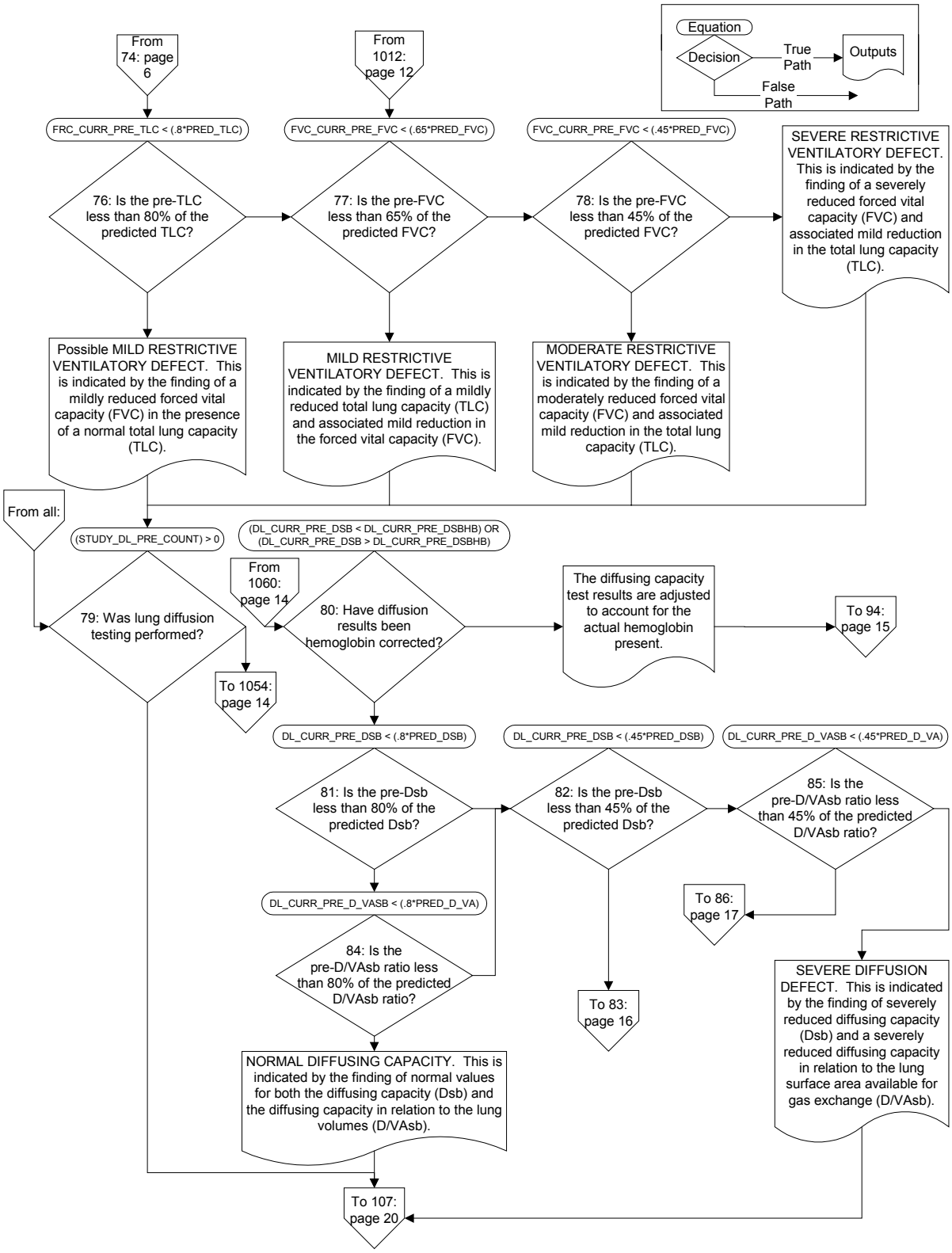
Flow Chart page 10


Equation
Decision
True Path
Outputs
False Path
From 1069: page 10
BBX_CURR_PRE_RV > (1.2*PRED_RV)
1001: Is the pre-RV greater than 120% of the predicted RV?
The obstructive pulmonary impairment is further confirmed by the finding of an elevated residual volume (RV), which most likely indicates AIR TRAPPING secondary to the obstructive process.
BBX_CURR_PRE_TLC > (1.2*PRED_TLC)
1002: Is the pre-TLC greater than 120% of the predicted TLC?
NO RESTRICTIVE VENTILATORY DEFECT. The increased total lung capacity (TLC) indicates the presence of an OVER DISTENDED LUNG, most likely as a result of chronic air trapping secondary to an obstructive process. Additionally, the presence of any superimposed restrictive ventilatory defect is ruled out by this finding.
BBX_CURR_PRE_TLC < (.45*PRED_TLC)
1003: Is the pre-TLC less than 45% of the predicted TLC?
The finding of a severely reduced total lung capacity (TLC) indicates a SUPERIMPOSED SEVERE RESTRICTIVE VENTILATORY DEFECT.
BBX_CURR_PRE_TLC < (.65*PRED_TLC)
1004: Is the pre-TLC less than 65% of the predicted TLC?
The finding of a moderately reduced total lung capacity (TLC) indicates a SUPERIMPOSED MODERATE RESTRICTIVE VENTILATORY DEFECT.
BBX_CURR_PRE_TLC < (.80*PRED_TLC)
1005: Is the pre-TLC less than 80% of the predicted TLC?
The finding of a mildly reduced total lung capacity (TLC) indicates a SUPERIMPOSED MILD RESTRICTIVE VENTILATORY DEFECT.
NO RESTRICTIVE VENTILATORY DEFECT. The lung volume test performed by the steady state helium dilution method is within normal limits indicating the absence of a superimposed restrictive ventilatory defect.
To 79: page 13

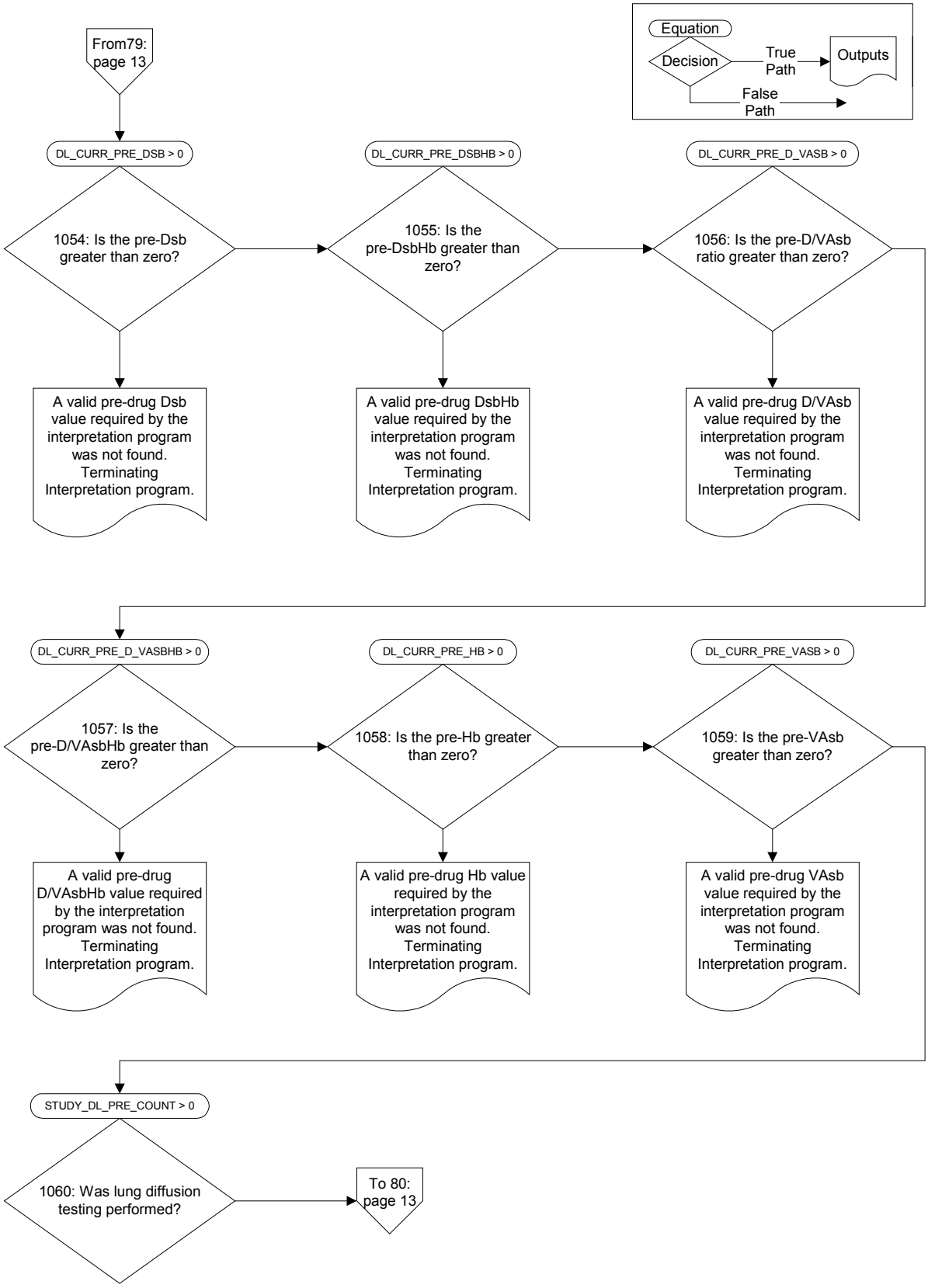
Flow Chart page 11


From 1077: page 9
Equation
Decision
True Path
Outputs
False Path
BBX_CURR_PRE_TLC < (.45*PRED_TLC)
1010: Is the pre-TLC less than 45% of the predicted TLC?
SEVERE RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a severely reduced total lung capacity (TLC) and associated reduction in the forced vital capacity (FVC).
To 79: page 13
BBX_CURR_PRE_TLC < (.65*PRED_TLC)
1011: Is the pre-TLC less than 65% of the predicted TLC?
To 75: page 6
BBX_CURR_PRE_TLC < (.80*PRED_TLC)
1012: Is the pre-TLC less than 80% of the predicted TLC?
To 77: page 13
Possible MILD RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a mildly reduced forced vital capacity (FVC) in the presence of a normal total lung capacity (TLC).
To 79: page 13
From 1073: page 10
BBX_CURR_PRE_RV > (1.2*PRED_RV)
1007: Is the pre-RV greater than 120% of the predicted RV?
The increased residual volume (RV) and total lung capacity (TLC) indicate the possibility of a MILD DEGREE OF HYPERINFLATION.
BBX_CURR_PRE_RV < (.80*PRED_RV)
1008: Is the pre-RV less than 80% of the predicted RV?
The decreased residual volume (RV) and total lung capacity (TLC) indicate the possibility of a MILD DEGREE OF RESTRICTIVE VENTILATORY DEFECT.
NORMAL LUNG VOLUME VALUES indicate the absence of any hyperinflation, air trapping, or restrictive process.
To 79: page 13

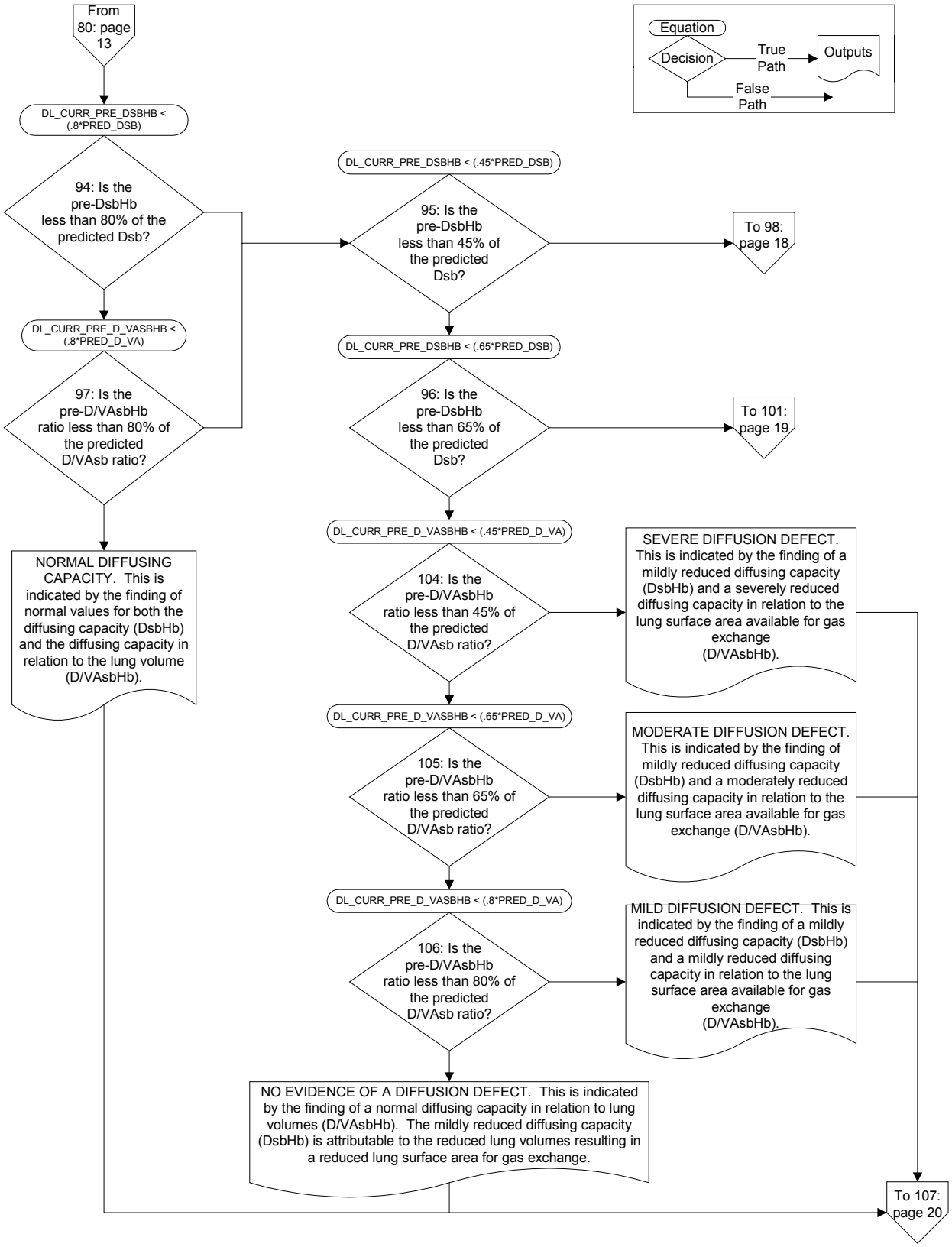
Flow Chart page 12


Equation
Decision
True Path
Outputs
False Path
From 74: page 6
From 1012: page 12
FRC_CURR_PRE_TLC < (.8*PRED_TLC)
FVC_CURR_PRE_FVC < (.65*PRED_FVC)
FVC_CURR_PRE_FVC < (.45*PRED_FVC)
76: Is the pre-TLC less than 80% of the predicted TLC?
77: Is the pre-FVC less than 65% of the predicted FVC?
78: Is the pre-FVC less than 45% of the predicted FVC?
SEVERE RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a severely reduced forced vital capacity (FVC) and associated mild reduction in the total lung capacity (TLC).
Possible MILD RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a mildly reduced forced vital capacity (FVC) in the presence of a normal total lung capacity (TLC).
MILD RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a mildly reduced total lung capacity (TLC) and associated mild reduction in the forced vital capacity (FVC).
MODERATE RESTRICTIVE VENTILATORY DEFECT. This is indicated by the finding of a moderately reduced forced vital capacity (FVC) and associated mild reduction in the total lung capacity (TLC).
From all:
(STUDY_DL_PRE_COUNT) > 0
(DL_CURR_PRE_DSB < DL_CURR_PRE_DSBHB) OR (DL_CURR_PRE_DSB > DL_CURR_PRE_DSBHB)
From 1060: page 14
79: Was lung diffusion testing performed?
80: Have diffusion results been hemoglobin corrected?
The diffusing capacity test results are adjusted to account for the actual hemoglobin present.
To 94: page 15
To 1054: page 14
DL_CURR_PRE_DSB < (.8*PRED_DSB)
DL_CURR_PRE_DSB < (.45*PRED_DSB)
DL_CURR_PRE_D_VASB < (.45*PRED_D_VA)
81: Is the pre-Dsb less than 80% of the predicted Dsb?
82: Is the pre-Dsb less than 45% of the predicted Dsb?
85: Is the pre-D/VAsb ratio less than 45% of the predicted D/VAsb ratio?
To 86: page 17
DL_CURR_PRE_D_VASB < (.8*PRED_D_VA)
84: Is the pre-D/VAsb ratio less than 80% of the predicted D/VAsb ratio?
To 83: page 16
SEVERE DIFFUSION DEFECT. This is indicated by the finding of severely reduced diffusing capacity (Dsb) and a severely reduced diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsb).
NORMAL DIFFUSING CAPACITY. This is indicated by the finding of normal values for both the diffusing capacity (Dsb) and the diffusing capacity in relation to the lung volumes (D/VAsb).
To 107: page 20

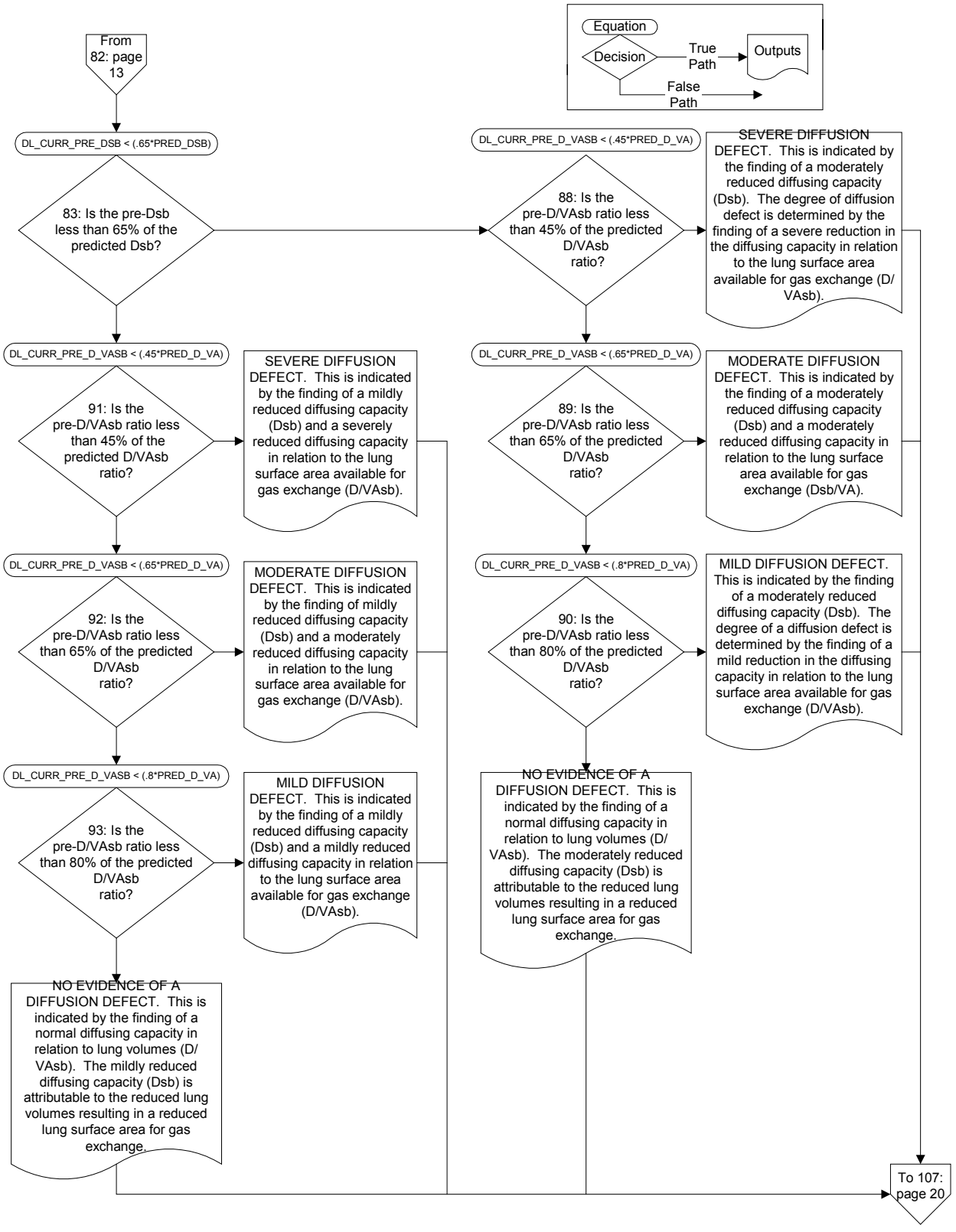
Flow Chart page 13


Equation
Decision
True Path
Outputs
False Path
From79: page 13
DL_CURR_PRE_DSB > 0
1054: Is the pre-Dsb greater than zero?
A valid pre-drug Dsb value required by the interpretation program was not found. Terminating Interpretation program.
DL_CURR_PRE_DSBHB > 0
1055: Is the pre-DsbHb greater than zero?
A valid pre-drug DsbHb value required by the interpretation program was not found. Terminating Interpretation program.
DL_CURR_PRE_D_VASB > 0
1056: Is the pre-D/VAsb ratio greater than zero?
A valid pre-drug D/VAsb value required by the interpretation program was not found. Terminating Interpretation program.
DL_CURR_PRE_D_VASBHB > 0
1057: Is the pre-D/VAsbHb greater than zero?
A valid pre-drug D/VAsbHb value required by the interpretation program was not found. Terminating Interpretation program.
DL_CURR_PRE_HB > 0
1058: Is the pre-Hb greater than zero?
A valid pre-drug Hb value required by the interpretation program was not found. Terminating Interpretation program.
DL_CURR_PRE_VASB > 0
1059: Is the pre-VAsb greater than zero?
A valid pre-drug VAsb value required by the interpretation program was not found. Terminating Interpretation program.
STUDY_DL_PRE_COUNT > 0
1060: Was lung diffusion testing performed?
To 80: page 13

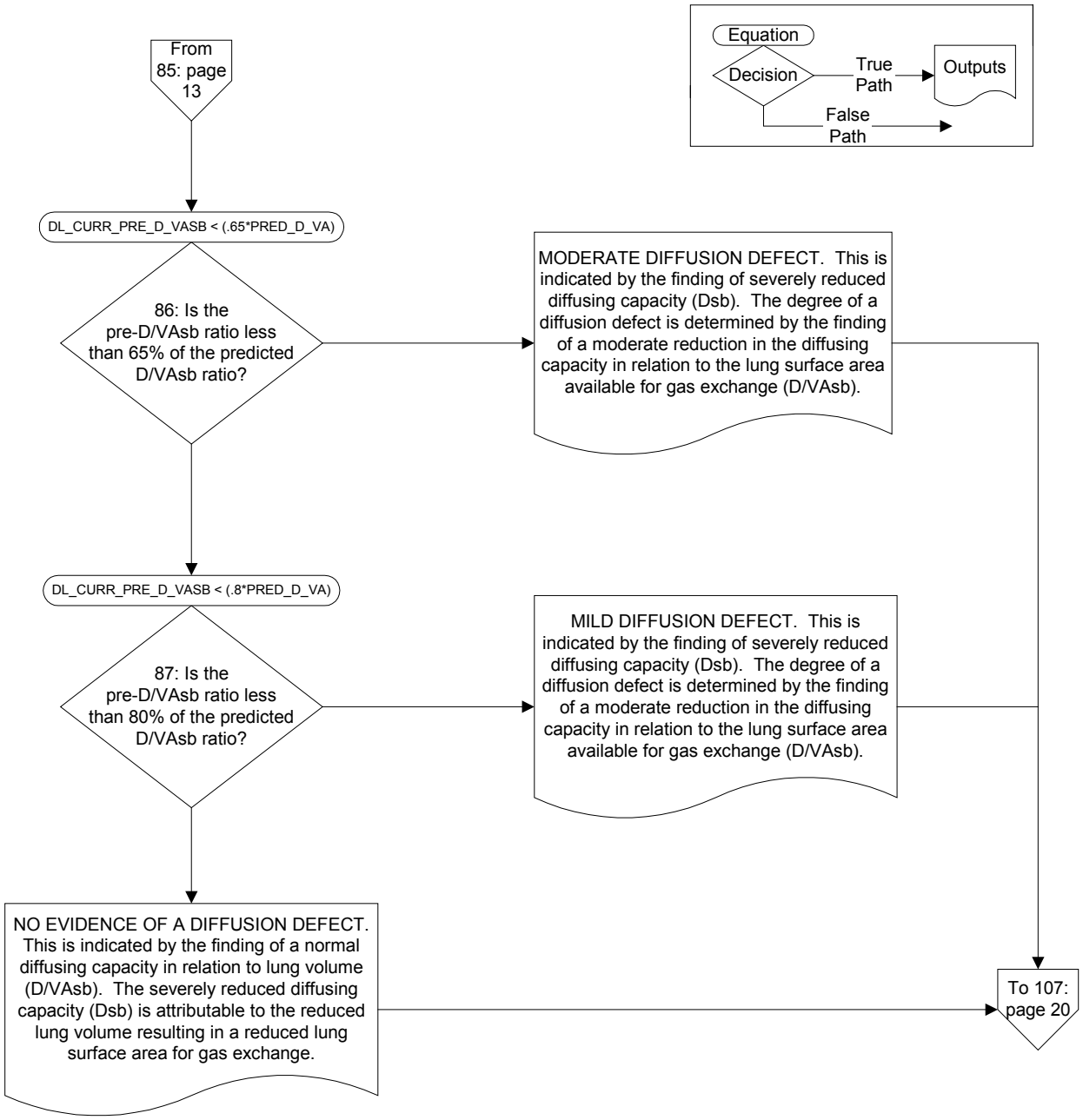
Flow Chart page 14


From 80: page 13
Equation
Decision
True Path
Outputs
False Path
DL_CURR_PRE_DSBHB < (.8*PRED_DSB)
94: Is the pre-DsbHb less than 80% of the predicted Dsb?
DL_CURR_PRE_DSBHB < (.45*PRED_DSB)
95: Is the pre-DsbHb less than 45% of the predicted Dsb?
To 98: page 18
DL_CURR_PRE_D_VASBHB < (.8*PRED_D_VA)
97: Is the pre-D/VAsbHb ratio less than 80% of the predicted D/VAsb ratio?
DL_CURR_PRE_DSBHB < (.65*PRED_DSB)
96: Is the pre-DsbHb less than 65% of the predicted Dsb?
To 101: page 19
NORMAL DIFFUSING CAPACITY. This is indicated by the finding of normal values for both the diffusing capacity (DsbHb) and the diffusing capacity in relation to the lung volume (D/VAsbHb).
DL_CURR_PRE_D_VASBHB < (.45*PRED_D_VA)
104: Is the pre-D/VAsbHb ratio less than 45% of the predicted D/VAsb ratio?
SEVERE DIFFUSION DEFECT. This is indicated by the finding of a mildly reduced diffusing capacity (DsbHb) and a severely reduced diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsbHb).
DL_CURR_PRE_D_VASBHB < (.65*PRED_D_VA)
105: Is the pre-D/VAsbHb ratio less than 65% of the predicted D/VAsb ratio?
MODERATE DIFFUSION DEFECT. This is indicated by the finding of mildly reduced diffusing capacity (DsbHb) and a moderately reduced diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsbHb).
DL_CURR_PRE_D_VASBHB < (.8*PRED_D_VA)
106: Is the pre-D/VAsbHb ratio less than 80% of the predicted D/VAsb ratio?
MILD DIFFUSION DEFECT. This is indicated by the finding of a mildly reduced diffusing capacity (DsbHb) and a mildly reduced diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsbHb).
NO EVIDENCE OF A DIFFUSION DEFECT. This is indicated by the finding of a normal diffusing capacity in relation to lung volumes (D/VAsbHb). The mildly reduced diffusing capacity (DsbHb) is attributable to the reduced lung volumes resulting in a reduced lung surface area for gas exchange.
To 107: page 20

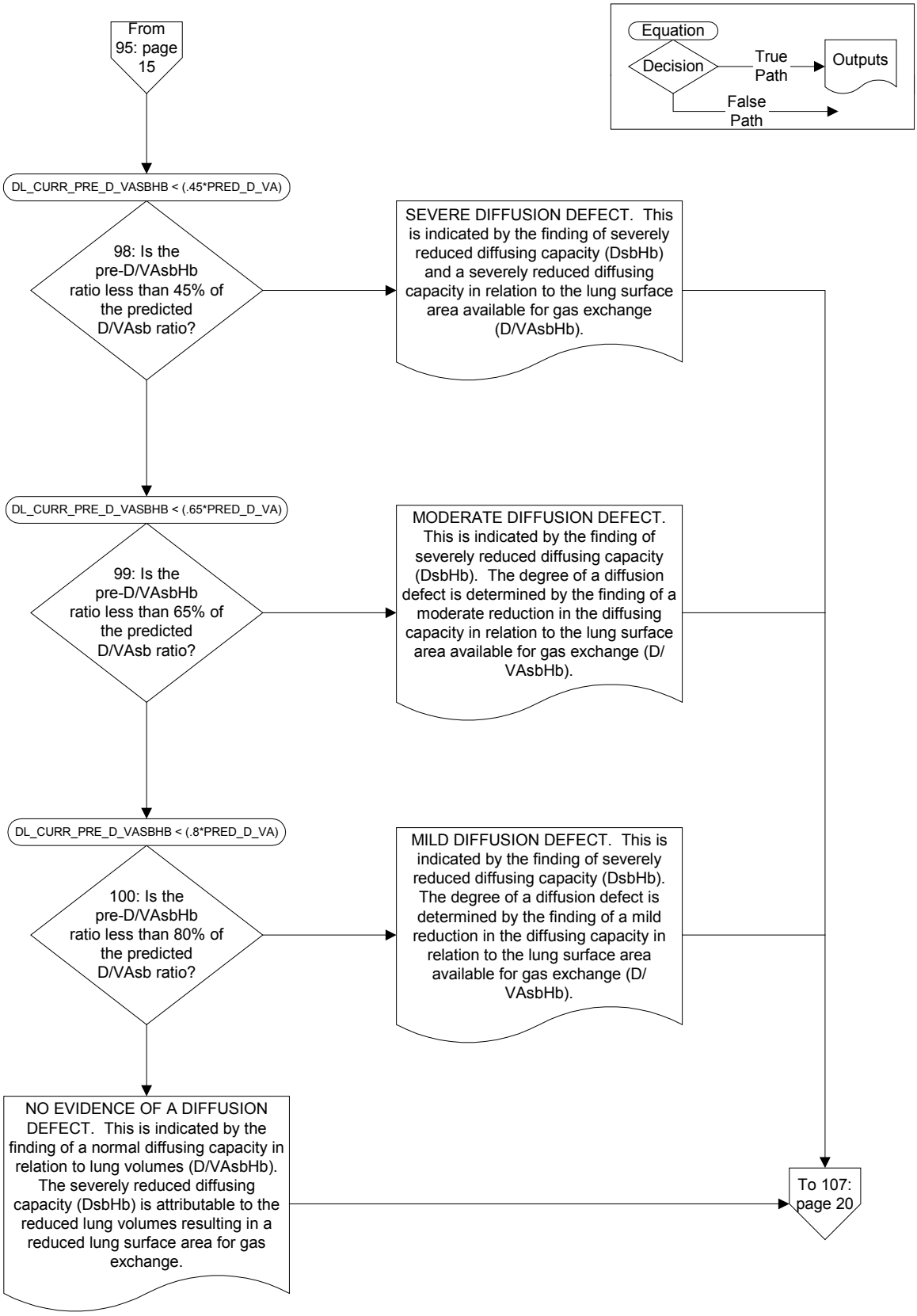
Flow Chart page 15


Equation
Decision
True Path
Outputs
False Path
From 82: page 13
DL_CURR_PRE_DSB < (.65*PRED_DSB)
83: Is the pre-Dsb less than 65% of the predicted Dsb?
DL_CURR_PRE_D_VASB < (.45*PRED_D_VA)
91: Is the pre-D/VAsb ratio less than 45% of the predicted D/VAsb ratio?
SEVERE DIFFUSION DEFECT. This is indicated by the finding of a mildly reduced diffusing capacity (Dsb) and a severely reduced diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsb).
DL_CURR_PRE_D_VASB < (.65*PRED_D_VA)
92: Is the pre-D/VAsb ratio less than 65% of the predicted D/VAsb ratio?
MODERATE DIFFUSION DEFECT. This is indicated by the finding of mildly reduced diffusing capacity (Dsb) and a moderately reduced diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsb).
DL_CURR_PRE_D_VASB < (.8*PRED_D_VA)
93: Is the pre-D/VAsb ratio less than 80% of the predicted D/VAsb ratio?
MILD DIFFUSION DEFECT. This is indicated by the finding of a mildly reduced diffusing capacity (Dsb) and a mildly reduced diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsb).
NO EVIDENCE OF A DIFFUSION DEFECT. This is indicated by the finding of a normal diffusing capacity in relation to lung volumes (D/VAsb). The mildly reduced diffusing capacity (Dsb) is attributable to the reduced lung volumes resulting in a reduced lung surface area for gas exchange.
DL_CURR_PRE_D_VASB < (.45*PRED_D_VA)
88: Is the pre-D/VAsb ratio less than 45% of the predicted D/VAsb ratio?
SEVERE DIFFUSION DEFECT. This is indicated by the finding of a moderately reduced diffusing capacity (Dsb). The degree of diffusion defect is determined by the finding of a severe reduction in the diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsb).
DL_CURR_PRE_D_VASB < (.65*PRED_D_VA)
89: Is the pre-D/VAsb ratio less than 65% of the predicted D/VAsb ratio?
MODERATE DIFFUSION DEFECT. This is indicated by the finding of a moderately reduced diffusing capacity (Dsb) and a moderately reduced diffusing capacity in relation to the lung surface area available for gas exchange (Dsb/VA).
DL_CURR_PRE_D_VASB < (.8*PRED_D_VA)
90: Is the pre-D/VAsb ratio less than 80% of the predicted D/VAsb ratio?
MILD DIFFUSION DEFECT. This is indicated by the finding of a moderately reduced diffusing capacity (Dsb). The degree of a diffusion defect is determined by the finding of a mild reduction in the diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsb).
NO EVIDENCE OF A DIFFUSION DEFECT. This is indicated by the finding of a normal diffusing capacity in relation to lung volumes (D/VAsb). The moderately reduced diffusing capacity (Dsb) is attributable to the reduced lung volumes resulting in a reduced lung surface area for gas exchange.
To 107: page 20

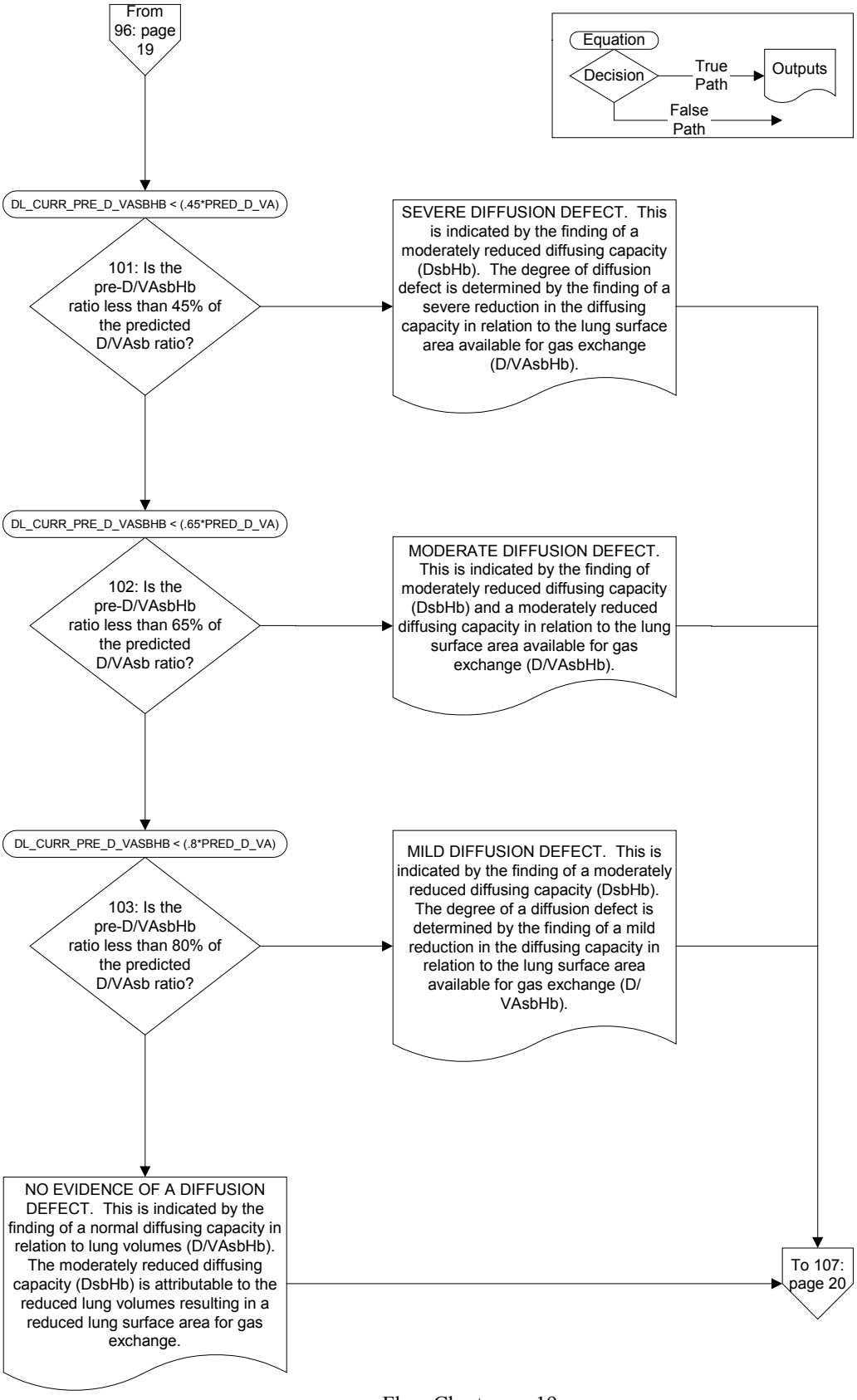
Flow Chart page 16


Equation
Decision
True Path
Outputs
False Path
From 85: page 13
DL_CURR_PRE_D_VASB < (.65*PRED_D_VA)
86: Is the pre-D/VAsb ratio less than 65% of the predicted D/VAsb ratio?
MODERATE DIFFUSION DEFECT. This is indicated by the finding of severely reduced diffusing capacity (Dsb). The degree of a diffusion defect is determined by the finding of a moderate reduction in the diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsb).
DL_CURR_PRE_D_VASB < (.8*PRED_D_VA)
87: Is the pre-D/VAsb ratio less than 80% of the predicted D/VAsb ratio?
MILD DIFFUSION DEFECT. This is indicated by the finding of severely reduced diffusing capacity (Dsb). The degree of a diffusion defect is determined by the finding of a moderate reduction in the diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsb).
NO EVIDENCE OF A DIFFUSION DEFECT. This is indicated by the finding of a normal diffusing capacity in relation to lung volume (D/VAsb). The severely reduced diffusing capacity (Dsb) is attributable to the reduced lung volume resulting in a reduced lung surface area for gas exchange.
To 107: page 20

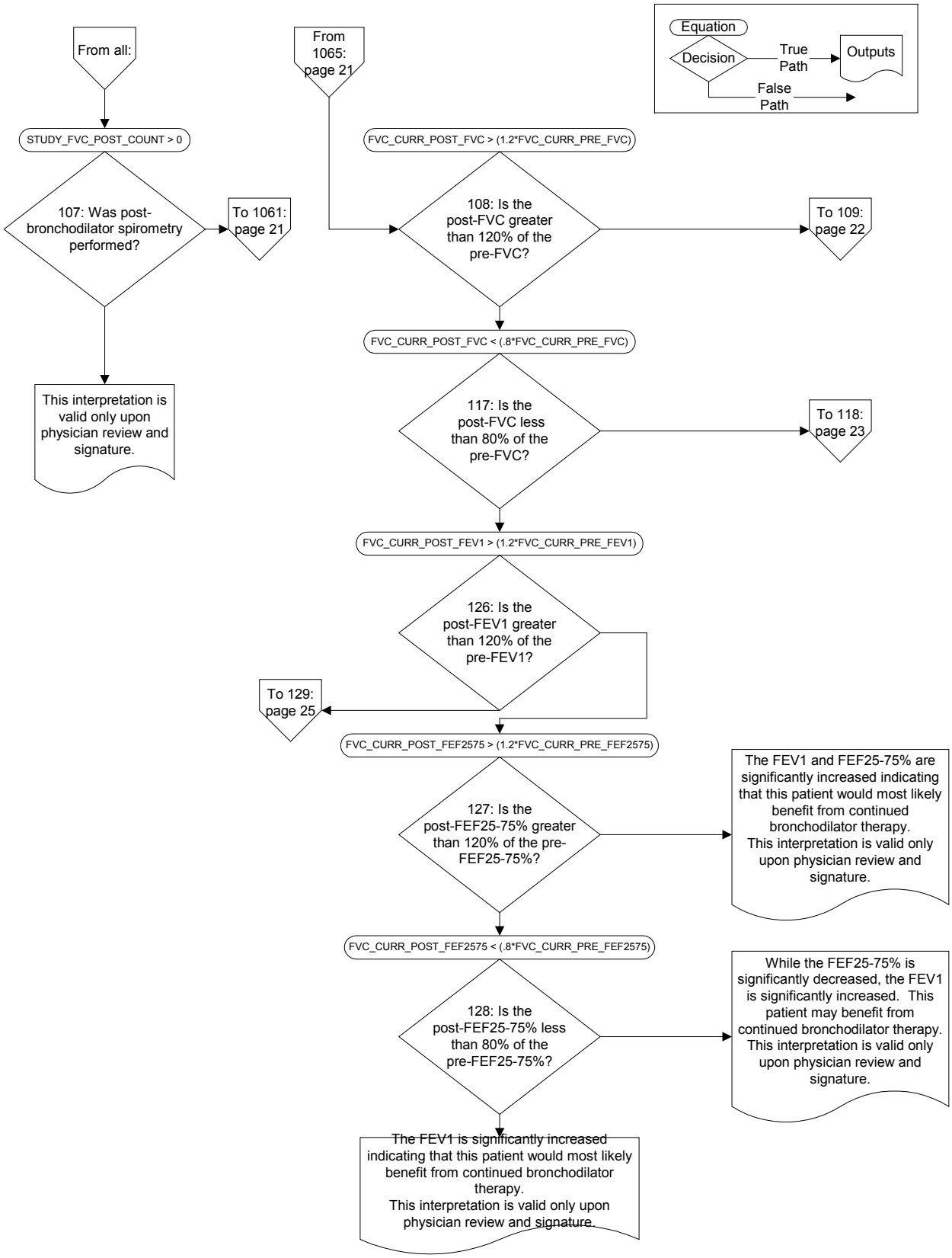
Flow Chart page 17


Equation
Decision
True Path
Outputs
False Path
From 95: page 15
DL_CURR_PRE_D_VASBHB < (.45*PRED_D_VA)
98: Is the pre-D/VAsbHb ratio less than 45% of the predicted D/VAsb ratio?
SEVERE DIFFUSION DEFECT. This is indicated by the finding of severely reduced diffusing capacity (DsbHb) and a severely reduced diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsbHb).
DL_CURR_PRE_D_VASBHB < (.65*PRED_D_VA)
99: Is the pre-D/VAsbHb ratio less than 65% of the predicted D/VAsb ratio?
MODERATE DIFFUSION DEFECT. This is indicated by the finding of severely reduced diffusing capacity (DsbHb). The degree of a diffusion defect is determined by the finding of a moderate reduction in the diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsbHb).
DL_CURR_PRE_D_VASBHB < (.8*PRED_D_VA)
100: Is the pre-D/VAsbHb ratio less than 80% of the predicted D/VAsb ratio?
MILD DIFFUSION DEFECT. This is indicated by the finding of severely reduced diffusing capacity (DsbHb). The degree of a diffusion defect is determined by the finding of a mild reduction in the diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsbHb).
NO EVIDENCE OF A DIFFUSION DEFECT. This is indicated by the finding of a normal diffusing capacity in relation to lung volumes (D/VAsbHb). The severely reduced diffusing capacity (DsbHb) is attributable to the reduced lung volumes resulting in a reduced lung surface area for gas exchange.
To 107: page 20

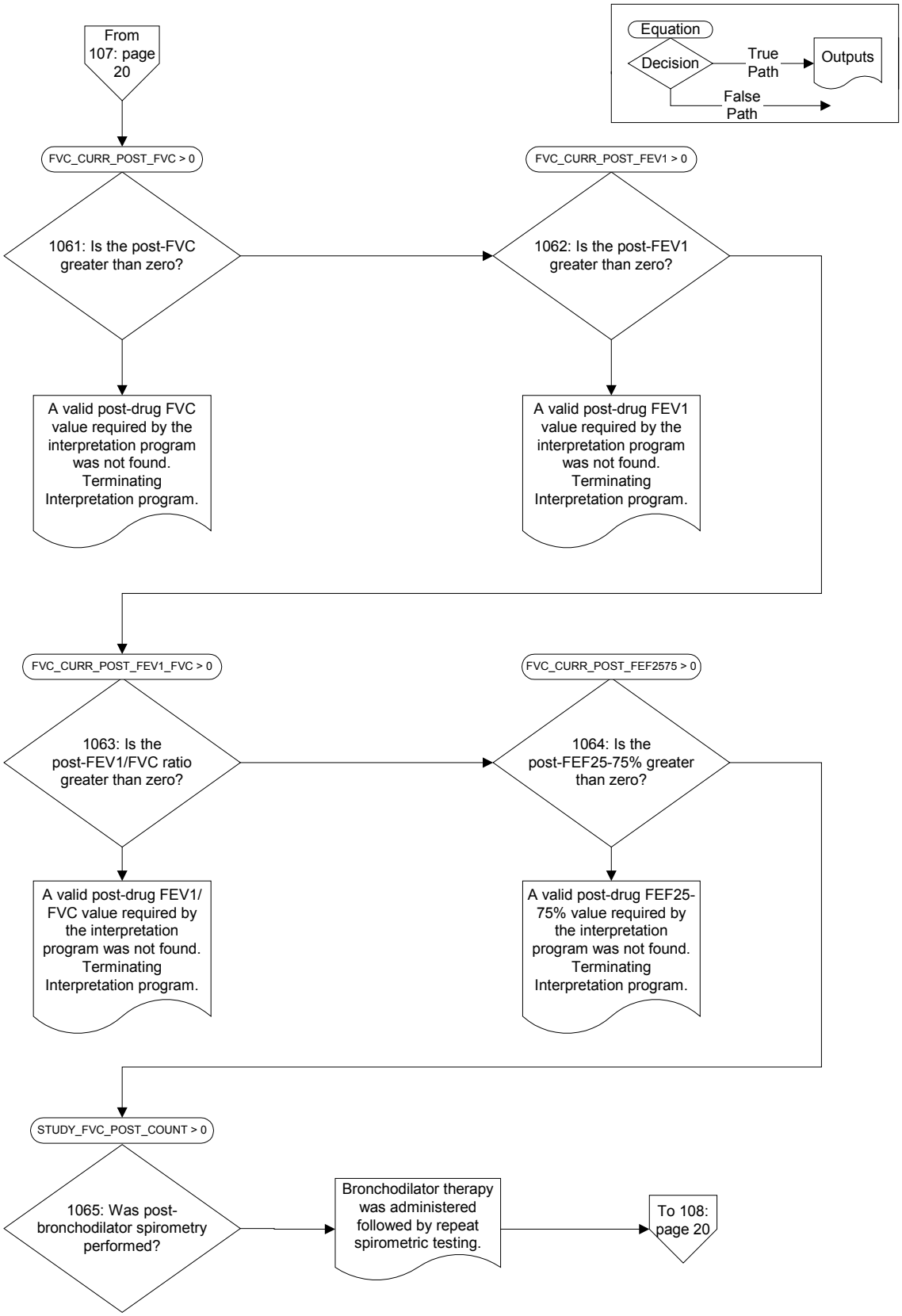
Flow Chart page 18


From 96: page 19
Equation
Decision
True Path
Outputs
False Path
DL_CURR_PRE_D_VASBHB < (.45*PRED_D_VA)
101: Is the pre-D/VAsbHb ratio less than 45% of the predicted D/VAsb ratio?
SEVERE DIFFUSION DEFECT. This is indicated by the finding of a moderately reduced diffusing capacity (DsbHb). The degree of diffusion defect is determined by the finding of a severe reduction in the diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsbHb).
DL_CURR_PRE_D_VASBHB < (.65*PRED_D_VA)
102: Is the pre-D/VAsbHb ratio less than 65% of the predicted D/VAsb ratio?
MODERATE DIFFUSION DEFECT. This is indicated by the finding of moderately reduced diffusing capacity (DsbHb) and a moderately reduced diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsbHb).
DL_CURR_PRE_D_VASBHB < (.8*PRED_D_VA)
103: Is the pre-D/VAsbHb ratio less than 80% of the predicted D/VAsb ratio?
MILD DIFFUSION DEFECT. This is indicated by the finding of a moderately reduced diffusing capacity (DsbHb). The degree of a diffusion defect is determined by the finding of a mild reduction in the diffusing capacity in relation to the lung surface area available for gas exchange (D/VAsbHb).
NO EVIDENCE OF A DIFFUSION DEFECT. This is indicated by the finding of a normal diffusing capacity in relation to lung volumes (D/VAsbHb). The moderately reduced diffusing capacity (DsbHb) is attributable to the reduced lung volumes resulting in a reduced lung surface area for gas exchange.
To 107: page 20

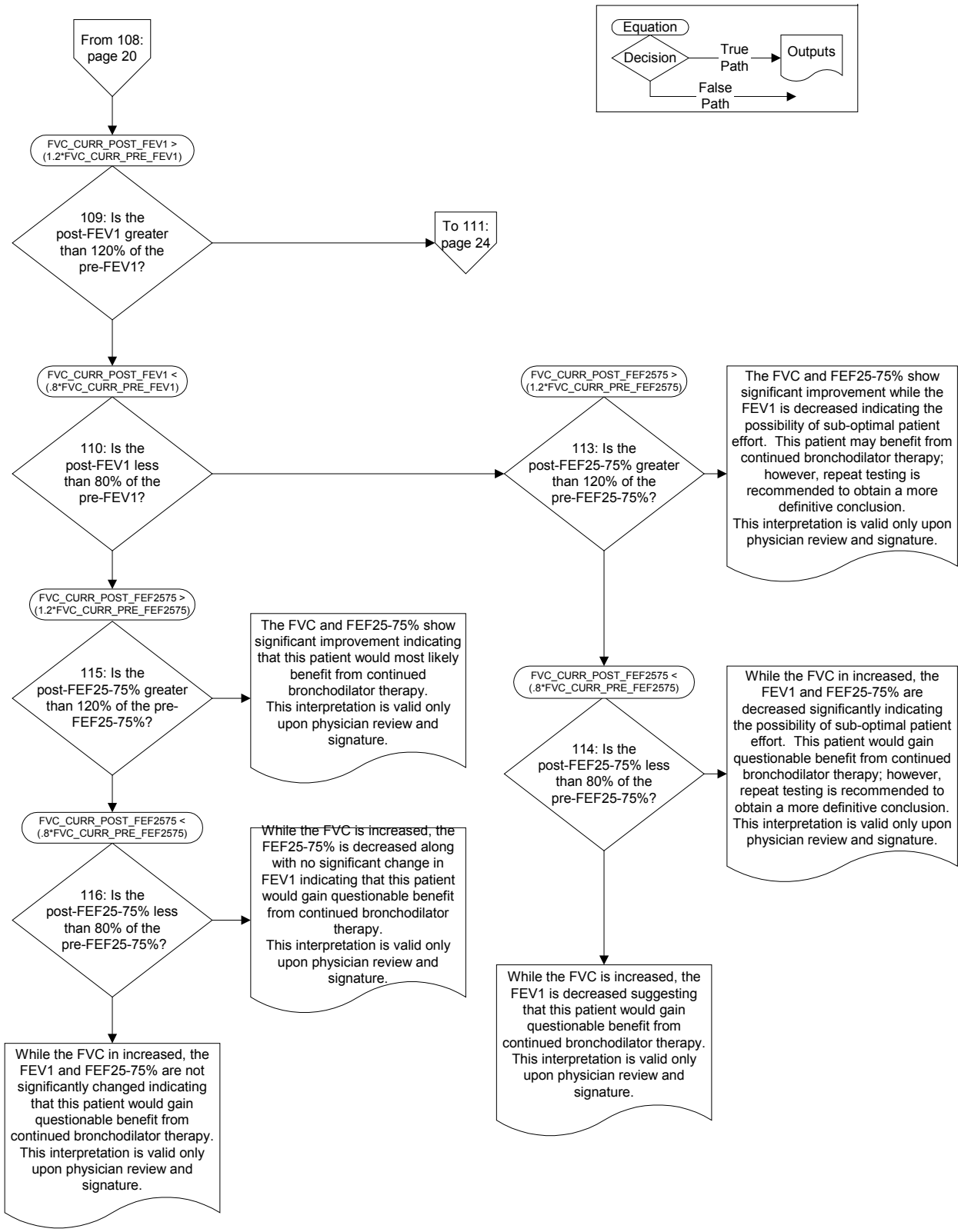
Flow Chart page 19


Equation
Decision
True Path
Outputs
False Path
From all:
STUDY_FVC_POST_COUNT > 0
107: Was post-bronchodilator spirometry performed?
To 1061: page 21
This interpretation is valid only upon physician review and signature.
From 1065: page 21
FVC_CURR_POST_FVC > (1.2*FVC_CURR_PRE_FVC)
108: Is the post-FVC greater than 120% of the pre-FVC?
To 109: page 22
FVC_CURR_POST_FVC < (.8*FVC_CURR_PRE_FVC)
117: Is the post-FVC less than 80% of the pre-FVC?
To 118: page 23
FVC_CURR_POST_FEV1 > (1.2*FVC_CURR_PRE_FEV1)
126: Is the post-FEV1 greater than 120% of the pre-FEV1?
To 129: page 25
FVC_CURR_POST_FEF2575 > (1.2*FVC_CURR_PRE_FEF2575)
127: Is the post-FEF25-75% greater than 120% of the pre-FEF25-75%?
The FEV1 and FEF25-75% are significantly increased indicating that this patient would most likely benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 < (.8*FVC_CURR_PRE_FEF2575)
128: Is the post-FEF25-75% less than 80% of the pre-FEF25-75%?
While the FEF25-75% is significantly decreased, the FEV1 is significantly increased. This patient may benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
The FEV1 is significantly increased indicating that this patient would most likely benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.

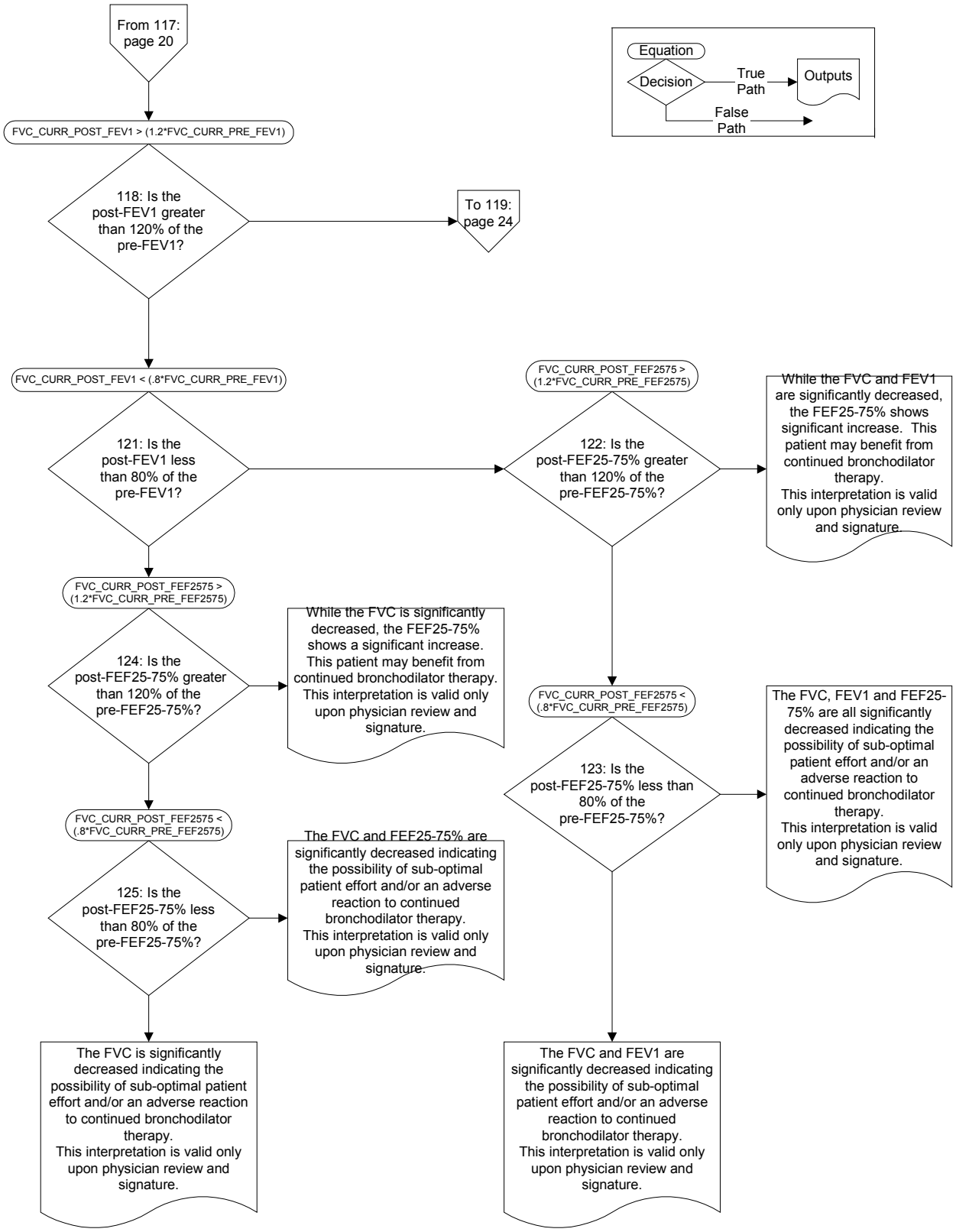
Flow Chart page 20


Equation
Decision
True Path
Outputs
False Path
From 107: page 20
FVC_CURR_POST_FVC > 0
1061: Is the post-FVC greater than zero?
A valid post-drug FVC value required by the interpretation program was not found. Terminating Interpretation program.
FVC_CURR_POST_FEV1 > 0
1062: Is the post-FEV1 greater than zero?
A valid post-drug FEV1 value required by the interpretation program was not found. Terminating Interpretation program.
FVC_CURR_POST_FEV1_FVC > 0
1063: Is the post-FEV1/FVC ratio greater than zero?
A valid post-drug FEV1/ FVC value required by the interpretation program was not found. Terminating Interpretation program.
FVC_CURR_POST_FEF2575 > 0
1064: Is the post-FEF25-75% greater than zero?
A valid post-drug FEF25-75% value required by the interpretation program was not found. Terminating Interpretation program.
STUDY_FVC_POST_COUNT > 0
1065: Was post-bronchodilator spirometry performed?
Bronchodilator therapy was administered followed by repeat spirometric testing.
To 108: page 20

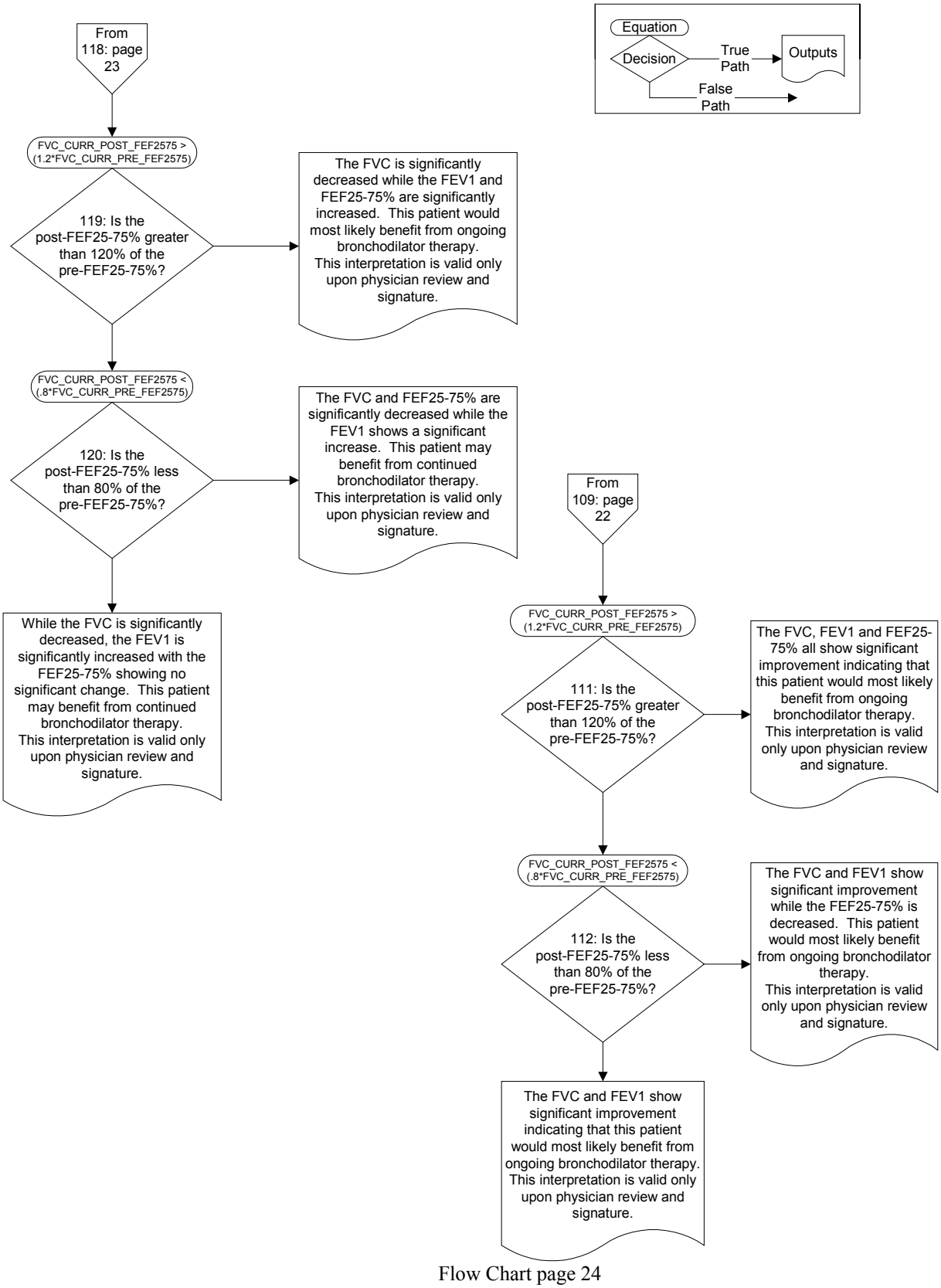
Flow Chart page 21


Equation
Decision
True Path
Outputs
False Path
From 108: page 20
FVC_CURR_POST_FEV1 > (1.2*FVC_CURR_PRE_FEV1)
109: Is the post-FEV1 greater than 120% of the pre-FEV1?
To 111: page 24
FVC_CURR_POST_FEV1 < (.8*FVC_CURR_PRE_FEV1)
110: Is the post-FEV1 less than 80% of the pre-FEV1?
FVC_CURR_POST_FEF2575 > (1.2*FVC_CURR_PRE_FEF2575)
113: Is the post-FEF25-75% greater than 120% of the pre-FEF25-75%?
The FVC and FEF25-75% show significant improvement while the FEV1 is decreased indicating the possibility of sub-optimal patient effort. This patient may benefit from continued bronchodilator therapy; however, repeat testing is recommended to obtain a more definitive conclusion. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 > (1.2*FVC_CURR_PRE_FEF2575)
115: Is the post-FEF25-75% greater than 120% of the pre-FEF25-75%?
The FVC and FEF25-75% show significant improvement indicating that this patient would most likely benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 < (.8*FVC_CURR_PRE_FEF2575)
116: Is the post-FEF25-75% less than 80% of the pre-FEF25-75%?
While the FVC is increased, the FEF25-75% is decreased along with no significant change in FEV1 indicating that this patient would gain questionable benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
While the FVC in increased, the FEV1 and FEF25-75% are not significantly changed indicating that this patient would gain questionable benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 < (.8*FVC_CURR_PRE_FEF2575)
114: Is the post-FEF25-75% less than 80% of the pre-FEF25-75%?
While the FVC in increased, the FEV1 and FEF25-75% are decreased significantly indicating the possibility of sub-optimal patient effort. This patient would gain questionable benefit from continued bronchodilator therapy; however, repeat testing is recommended to obtain a more definitive conclusion. This interpretation is valid only upon physician review and signature.
While the FVC is increased, the FEV1 is decreased suggesting that this patient would gain questionable benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.

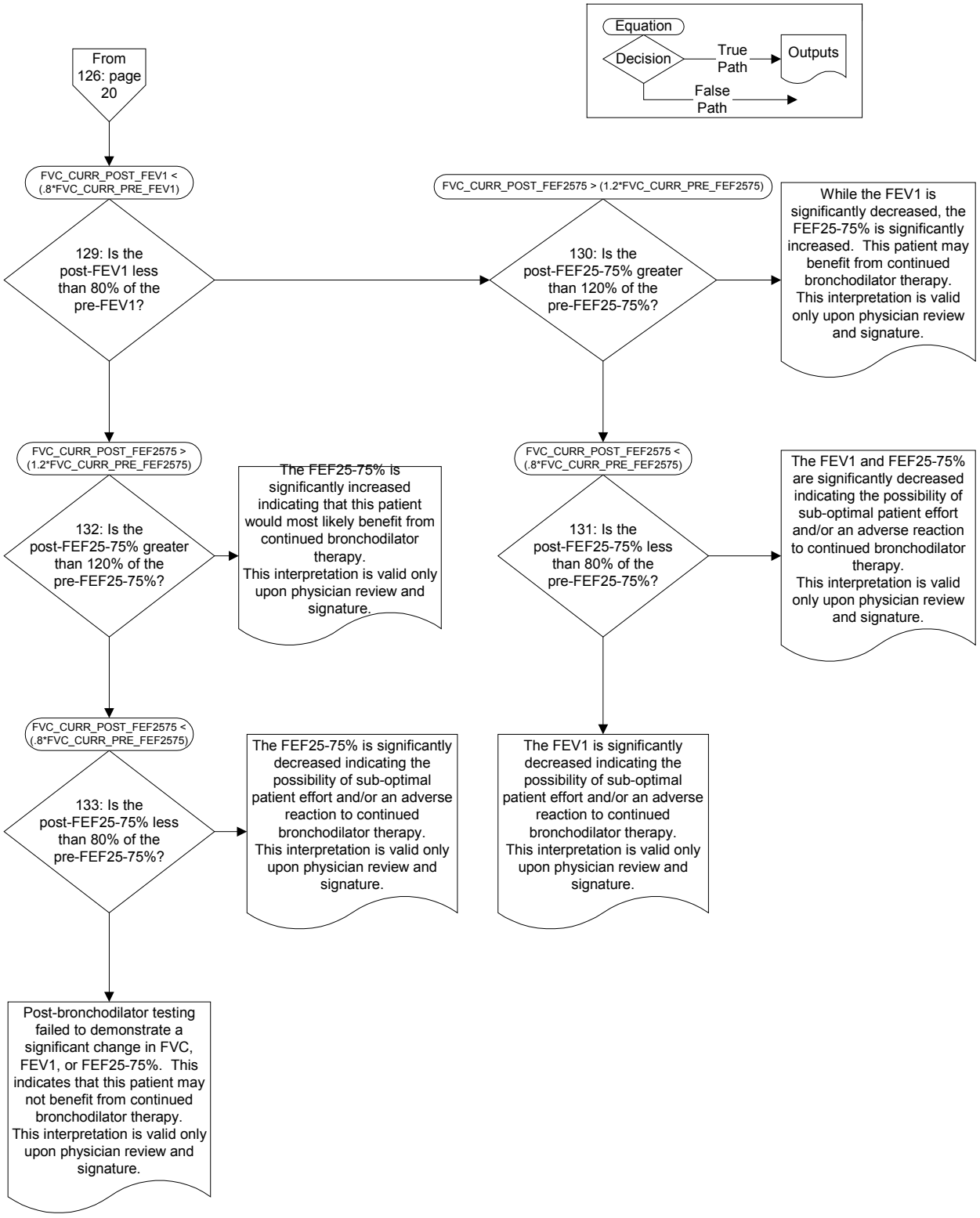
Flow Chart page 22


From 117: page 20
Equation
Decision
True Path
Outputs
False Path
FVC_CURR_POST_FEV1 > (1.2*FVC_CURR_PRE_FEV1)
118: Is the post-FEV1 greater than 120% of the pre-FEV1?
To 119: page 24
FVC_CURR_POST_FEV1 < (.8*FVC_CURR_PRE_FEV1)
121: Is the post-FEV1 less than 80% of the pre-FEV1?
FVC_CURR_POST_FEF2575 > (1.2*FVC_CURR_PRE_FEF2575)
122: Is the post-FEF25-75% greater than 120% of the pre-FEF25-75%?
While the FVC and FEV1 are significantly decreased, the FEF25-75% shows significant increase. This patient may benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 > (1.2*FVC_CURR_PRE_FEF2575)
124: Is the post-FEF25-75% greater than 120% of the pre-FEF25-75%?
While the FVC is significantly decreased, the FEF25-75% shows a significant increase. This patient may benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 < (.8*FVC_CURR_PRE_FEF2575)
123: Is the post-FEF25-75% less than 80% of the pre-FEF25-75%?
The FVC, FEV1 and FEF25-75% are all significantly decreased indicating the possibility of sub-optimal patient effort and/or an adverse reaction to continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 < (.8*FVC_CURR_PRE_FEF2575)
125: Is the post-FEF25-75% less than 80% of the pre-FEF25-75%?
The FVC and FEF25-75% are significantly decreased indicating the possibility of sub-optimal patient effort and/or an adverse reaction to continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
The FVC is significantly decreased indicating the possibility of sub-optimal patient effort and/or an adverse reaction to continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
The FVC and FEV1 are significantly decreased indicating the possibility of sub-optimal patient effort and/or an adverse reaction to continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.

Flow Chart page 23


Equation
Decision
True Path
Outputs
False Path
From 118: page 23
FVC_CURR_POST_FEF2575 > (1.2*FVC_CURR_PRE_FEF2575)
119: Is the post-FEF25-75% greater than 120% of the pre-FEF25-75%?
The FVC is significantly decreased while the FEV1 and FEF25-75% are significantly increased. This patient would most likely benefit from ongoing bronchodilator therapy. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 < (.8*FVC_CURR_PRE_FEF2575)
120: Is the post-FEF25-75% less than 80% of the pre-FEF25-75%?
The FVC and FEF25-75% are significantly decreased while the FEV1 shows a significant increase. This patient may benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
While the FVC is significantly decreased, the FEV1 is significantly increased with the FEF25-75% showing no significant change. This patient may benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
From 109: page 22
FVC_CURR_POST_FEF2575 > (1.2*FVC_CURR_PRE_FEF2575)
111: Is the post-FEF25-75% greater than 120% of the pre-FEF25-75%?
The FVC, FEV1 and FEF25-75% all show significant improvement indicating that this patient would most likely benefit from ongoing bronchodilator therapy. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 < (.8*FVC_CURR_PRE_FEF2575)
112: Is the post-FEF25-75% less than 80% of the pre-FEF25-75%?
The FVC and FEV1 show significant improvement while the FEF25-75% is decreased. This patient would most likely benefit from ongoing bronchodilator therapy. This interpretation is valid only upon physician review and signature.
The FVC and FEV1 show significant improvement indicating that this patient would most likely benefit from ongoing bronchodilator therapy. This interpretation is valid only upon physician review and signature.

Flow Chart page 24


Equation
Decision
True Path
Outputs
False Path
From 126: page 20
FVC_CURR_POST_FEV1 < (.8*FVC_CURR_PRE_FEV1)
129: Is the post-FEV1 less than 80% of the pre-FEV1?
FVC_CURR_POST_FEF2575 > (1.2*FVC_CURR_PRE_FEF2575)
130: Is the post-FEF25-75% greater than 120% of the pre-FEF25-75%?
While the FEV1 is significantly decreased, the FEF25-75% is significantly increased. This patient may benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 > (1.2*FVC_CURR_PRE_FEF2575)
132: Is the post-FEF25-75% greater than 120% of the pre-FEF25-75%?
The FEF25-75% is significantly increased indicating that this patient would most likely benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 < (.8*FVC_CURR_PRE_FEF2575)
131: Is the post-FEF25-75% less than 80% of the pre-FEF25-75%?
The FEV1 and FEF25-75% are significantly decreased indicating the possibility of sub-optimal patient effort and/or an adverse reaction to continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
FVC_CURR_POST_FEF2575 < (.8*FVC_CURR_PRE_FEF2575)
133: Is the post-FEF25-75% less than 80% of the pre-FEF25-75%?
The FEF25-75% is significantly decreased indicating the possibility of sub-optimal patient effort and/or an adverse reaction to continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
The FEV1 is significantly decreased indicating the possibility of sub-optimal patient effort and/or an adverse reaction to continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.
Post-bronchodilator testing failed to demonstrate a significant change in FVC, FEV1, or FEF25-75%. This indicates that this patient may not benefit from continued bronchodilator therapy. This interpretation is valid only upon physician review and signature.

Flow Chart page 25

# APPENDIX E – USING MICROSOFT® EXCEL WITH PLUS/SQL 2000

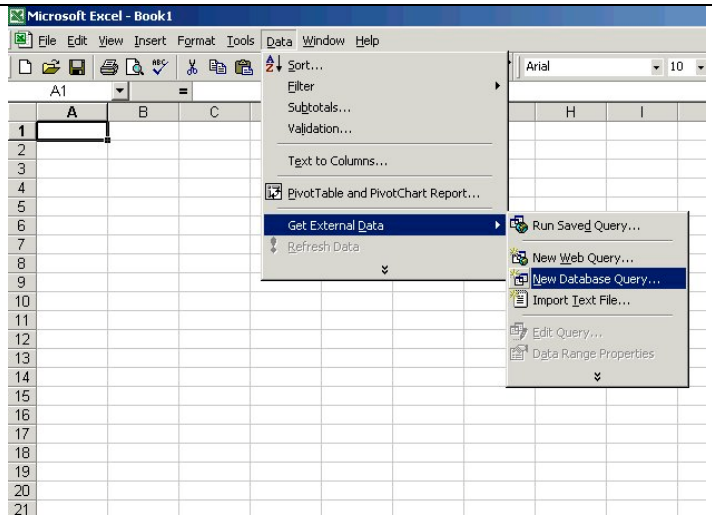
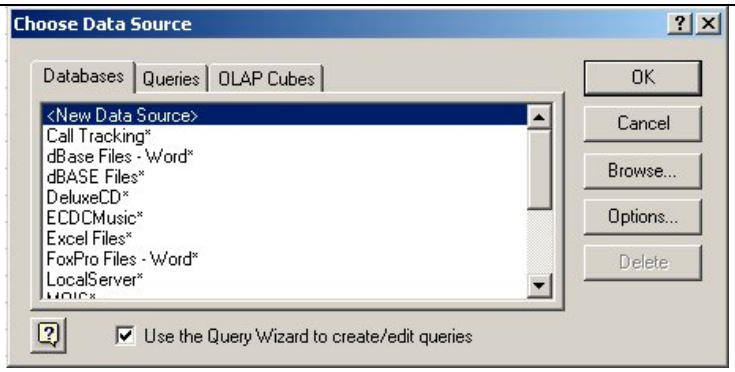
**Summary:**

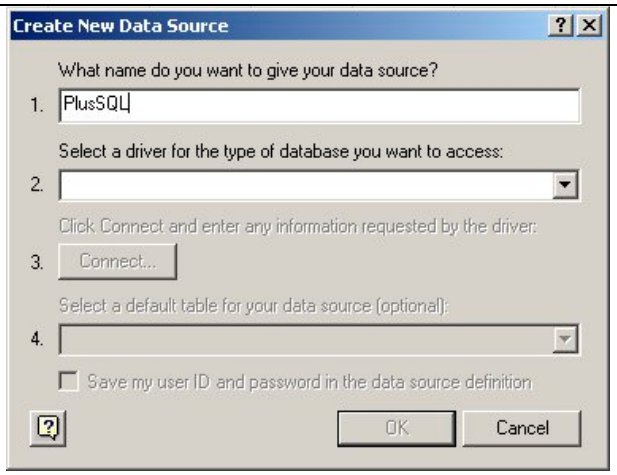
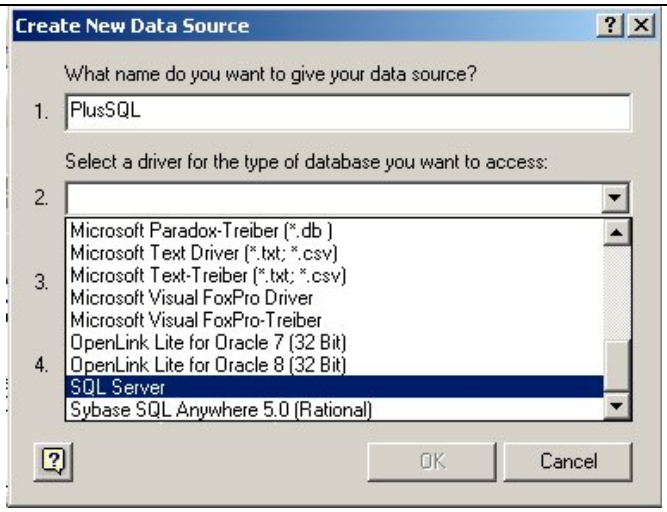
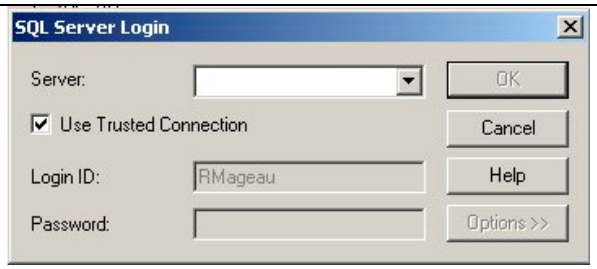
The purpose of this discussion is to introduce methods of harvesting data from within Excel using the interoperability of Microsoft SQL Server and the Microsoft Data Engine.

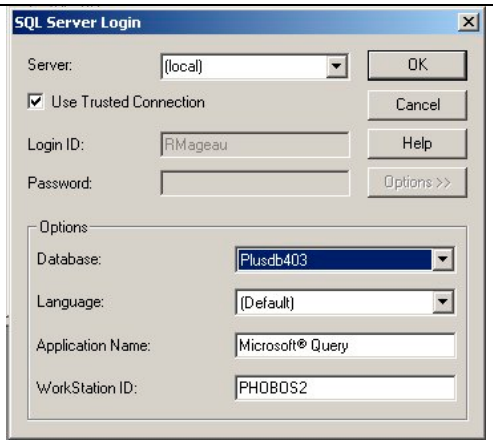
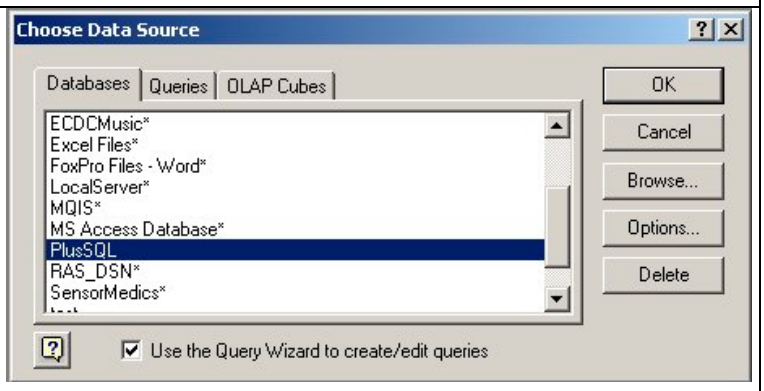
*Introduction*

Sometimes one needs more information, or it is necessary to manipulate data in a way that is not available from within Plus 2000. In these situations certain third party tools may be used to manipulate data. Plus 2000 uses the Microsoft Data Engine (a small-scale version of Microsoft SQL Server), whose power we can utilize inside other applications. Also, because the Microsoft Data Engine adheres to multiple standards (most notably the ODBC specification and OLEDB), the information inside the database can be used by other applications. This set of instructions illustrates its use inside Microsoft Excel.

The purpose of the following example is to show how one can retrieve data (in this example, FEFMAX) from the database for a particular patient. In this example we will retrieve the FEFMAX parameter from the database for a particular patient across all studies, and all efforts.

| | |
|---|---|
| Step 1 - Launch Excel | This should be available in the "Programs" menu off of the Start button. |
| Step 2 - Go to the Data Menu, select Get External Data, New Database Query |  |
| Step 3 - If you don't already have a Data Source (it's your first time doing this), select "<New Data Source>"and click 'OK'. If you already have a Data Source, skip to step 11. |  |

| | |
|---|---|
| Step 4 - Name the data source on Line 1. In this example, we use the name PlusSQL. |  |
| Step 5 - Choose the driver.<br>Plus 2000 uses the Microsoft SQL Server Engine. Look for an entry called "SQL Server" and choose that one. |  |
| Step 6 - Click the "Connect" button. | |
| Step 7 - Select the Server. If you are using a central SQL Server machine, select it from the dropdown menu. Also, if you know the machine name (either the local database, or a networked one) you select it here. If you know that the database is on the machine you are on, but don't know the name, type in the following without quotation marks "(local)". NOTE: You may connect to the database using 1 of 2 security options. If you are using built-in Windows® 2000 security, make sure "Use Trusted Connection" is checked (the default). If you are using SQL Server security, uncheck the box and provide your user name and password. Check with your systems administrator to find out which you are using. |  |

| | |
|---|---|
| Step 8 - Click on the "Options" button and select the database. It's the same name that it was given when the database was installed. |  |
| Step 9 - Choose "OK' to exit out of the dialog and continue. | |
| Step 10 - You should now be at the dialog that says "Create New Data source". Click "OK" | |
| Step 11 - Your New Data source is highlighted in the "Choose Data source Dialog". If you already had a data source, locate it and select it. Click "OK". |  |

Know your fields. We want to trend the FEFMAX parameter for a specific patient. We know the patient's unique patient number, so we will be basing the query off of that. We also know we will need the date the test was performed. So, this being said, we will look through our available options. *Patient Number* is a field in the patient table, along with other base information about the patient (others are things like first name, last name, etc). So we will select *patient num* from the patient table. In order to get to the FVC portion of the database, we will need to know the Study table. Select the *study guid* field from the study table, as we will need that information to link to the FVC data.

**NOTE:**

Data for tests are stored in tables that end with "calc". A table that ends with "graph" is something used internally to Plus 2000, and can't be retrieved without writing a program to do it.

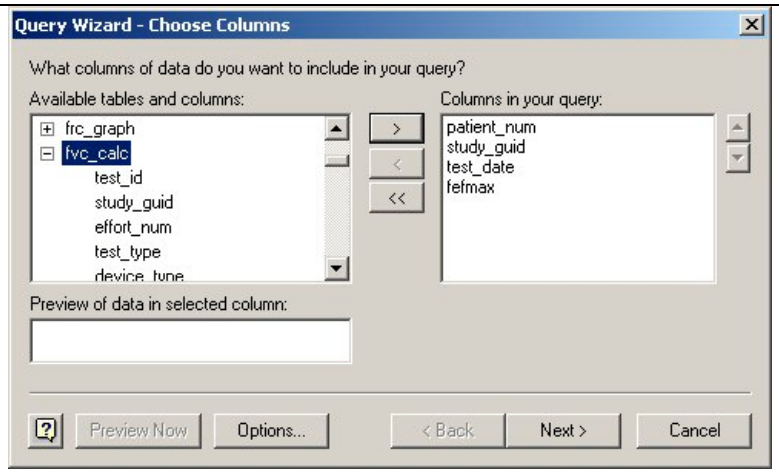
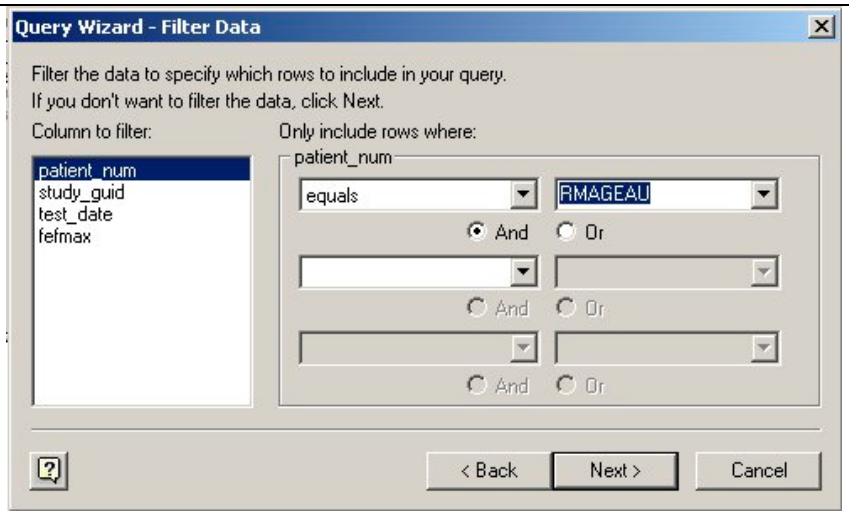
**NOTE:**

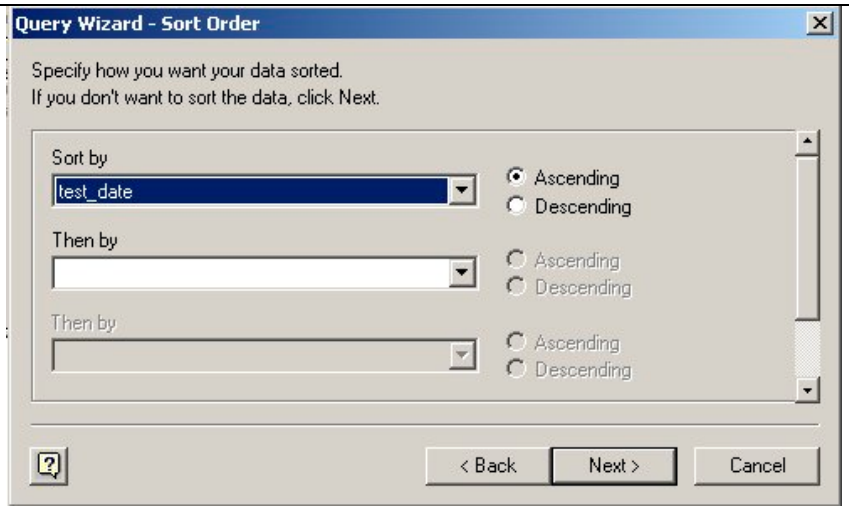
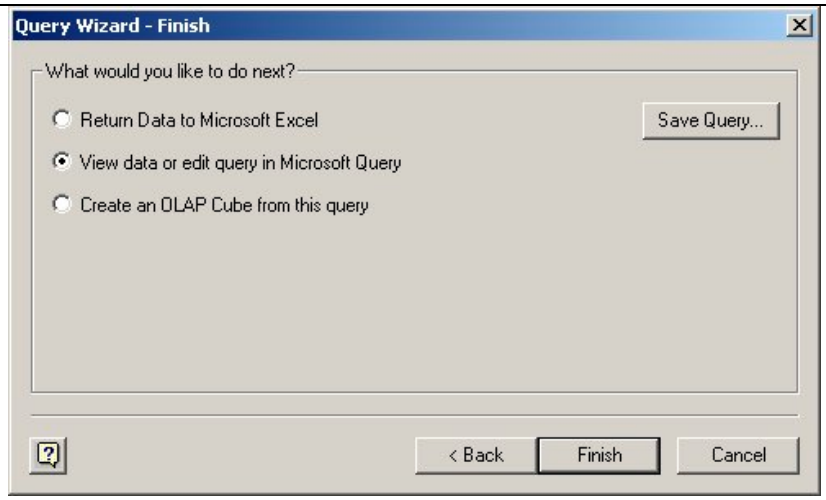
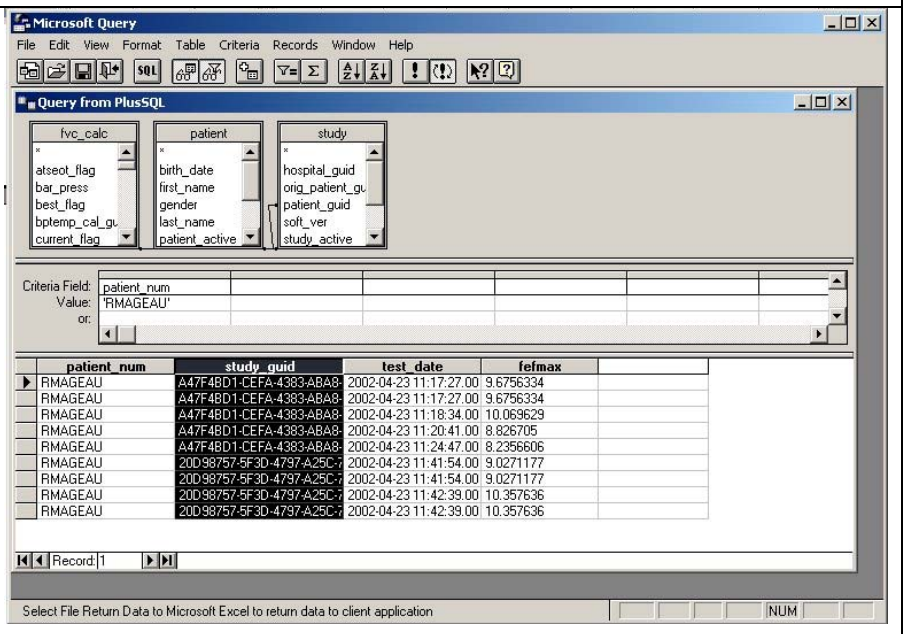
Do not attempt to add fields from other tests along with FVC data. Excel attempts internally to make a JOIN condition which will retrieve NO DATA when trying to get the records to populate a spreadsheet. You will need to create multiple queries using the Query Wizard, or create the actual SQL statements to do so.

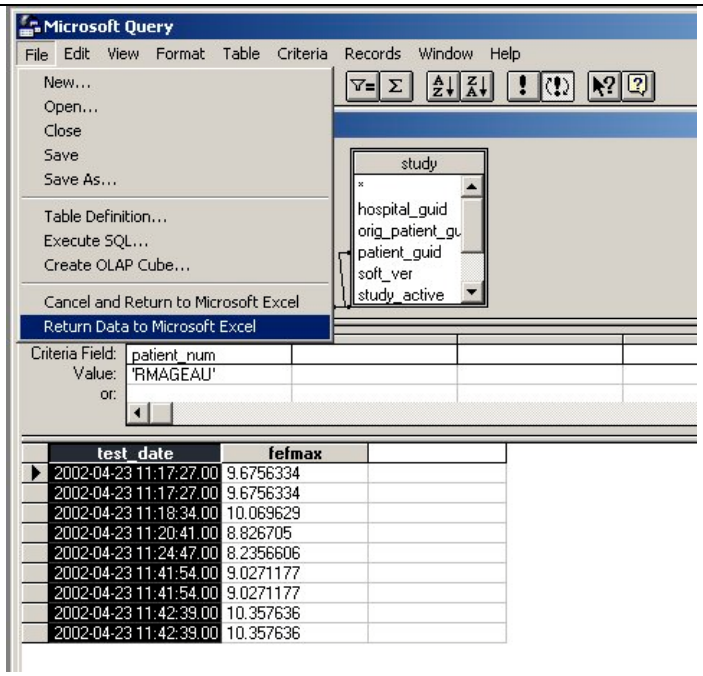
We will need the following fields in our query:

Patient Table : patient_num field
Study Table : study_guid
FVC_CALC table : test_date field
FVC_CALC table : fefmax field

Add these fields to the query, and choose “Next”.

| | |
|---|---|
| Step 12 - Add these fields to the query, and choose “Next”. |  |
| Step 13 - Filtering the data. In the “Column To Filter”, choose patient_num. In the first drop-down menu to the right, select ‘Equals” to get a precise match. If you then click the drop-down to the right of “Equals”, the program presents you with a list of values (in this case, Patient IDs) retrieved from the database. Select one you know will have data in it. Then click “Next”. |  |

| | |
|---|---|
| Step 14 - Sorting the data. We will want to sort by test_date criteria. Select test_date in the Sort-By drop down menu, and click 'Ascending'. Click "Next". |  |
| Step 15 - Edit the query. We can now either transfer the data into Excel, or manipulate it further with the Microsoft Query Editor. Click on "View or Edit data in Microsoft Query" and click the "Finish" button to see if the data is correct. |  |
| Step 16 - Unnecessary columns. There are 2 extra columns in this query, the patient_num field, and the study_guid field. We really don't need either one of these in Excel, so click on the column header (to select the entire column) and choose the *Records* menu, *Remove Column* option. We should now have only 2 columns, fef_max, and test_date. |  |

| | |
|---|---|
| Step 17 - Click on the File menu and choose “Return Data to Microsoft Excel”. Your data is now in Excel. |  |



Now that all of the information is inside Microsoft Excel, it is ready to be manipulated. For example, one could create a special graph using Excel’s extensive built-in graphing capabilities.

**Collins Medical, Inc.**
**220 Wood Road**
**Braintree, MA 02184-2403**
**(781)843-0610 (800)225-5157**
**FAX (781)843-4024**
**www.collinsmedical.com**